OUTLINES OF INDUSTRIAL ADMINISTRATION

OUTLINES OF
INDUSTRIAL ADMINISTRATION

BASED ON A COURSE OF LECTURES
GIVEN AT SHEFFIELD UNIVERSITY

BY

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PREFACE

THIS volume has been published in response to a number of requests that the series of Lectures given at the Sheffield University under the title of "Outlines of Industrial Administration" should be made available to the general public.

In writing the articles which form this volume, the authors have had constantly before them the difficulties of doing justice in concentrated form to a subject as wide as "Industrial Administration." The intention has not been to cover the whole field, but to put forward some of the more important fundamentals and principles, the consideration of which is general to the majority of Industrial Organizations.

In no field of human activity is the diversity of experience wider than in modern Industry, and any attempt to define the rules and lay down the laws which govern Industry must therefore be very imperfect. With a full realization of the difficulties of the subject with which this volume deals, the authors wish to express their desire that it may be regarded as an attempt to outline and not to elaborate the general considerations underlying the more important aspects of the subject.

At the present time, when Industrial Organization is only just beginning to be regarded as a matter for close study, the main features of this type of administration require, in their opinion, to be appreciated before the study of details is entered upon.

The great interest taken in the Lectures on which these articles are based, led the authors to feel that they might be found useful to a larger public and in this hope they trust they are not mistaken.

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OUTLINES OF INDUSTRIAL ADMINISTRATION

CHAPTER I

FINANCE

By H. G. Jenkins

The success of business is measured in financial terms, and is therefore dependent on the ability satisfactorily to finance the activity undertaken. Disaster awaits the industrial effort which is not built on a sound financial basis, and it follows that the finance of industry requires the most careful study and consideration in all its aspects. To determine to start a business without adequate study as to how it is to be financed is to court disaster, and, even if complete disaster is avoided, no business can fail to be crippled in its progress and development where financial stability is not adequately provided for.

Financial planning is essential to any business undertaking, and has in the past been given far too little consideration. This financial planning must review the whole of the elements concerned in the activity undertaken, and must therefore be fully understood.

Type of Company

The form of the proposed activity having been decided upon, an examination of the financial aspect of the proposals must be undertaken. Now the first

financial consideration must be the type of company most desirable under the circumstances. If it is proposed that there should be a single proprietor or partners, then the scope of the business is limited by the capacity of the individual or individuals to provide capital. If, on the other hand, the desire is to cover a wider scope, then it becomes necessary to interest outsiders—either friends or the public—and it is essential to determine what measure of control the originators desire to retain. The advantages and disadvantages of the company—the Limited or the Unlimited Company—must be examined and the type most suitable to the circumstances adopted. It is bad business to start at the individual and proceed through all the intermediate stages to the public company if the scope of the undertaking justifies its being launched on a wider scale. Time spent in planning to increase capital after a commencement has been made is valuable time taken from the real purpose of the business, which is Trading. In the case of a company, the Memorandum of Association should be drawn to cover a wide field so that the undertaking shall not be restricted.

Capital

The next step is the determination of the capital required, and its provision. It is equally as bad to under-capitalize as it is to over-capitalize. In the first case, the business is hindered from development, and, in the second, reasonable profits cannot be earned unless the whole of the capital is in use. In order to determine the volume of capital required, the market for the product, being the real limit to the enterprise, must be thoroughly investigated. No superficial

assumption that a market exists is a sufficient basis for starting a business.

The nature of the product determines the time taken to prepare it for sale. If a factoring business is being considered, we have to allow for stocks to be obtained, for time of transit to customer, and for the establishment required to contain the materials during the period between acquisition and despatch: if manufacturing, the period required for manufacturing processes, for obtaining stocks of raw materials, work-in-progress, and finished stocks; labour investment over this period and for the volume of business intended to be handled, present and future; the buildings required, the provision of machinery, tools, and plant, and handling; the cost of maintaining the workers, the volume of administration and control; and the cash locked up between the despatch and payment for deliveries of the finished product. These are main considerations. There are several matters which are incidental, and which must receive due attention, such as the need to determine whether it is intended to manufacture the tools required, provide for the welfare of the workers by canteen, etc., all of which are better considered before than after the undertaking is entered upon.

If the best class of labour is to be obtained and retained, under present-day conditions we must be prepared to provide safe hygienic conditions of working, etc., and all these require capital and must not be forgotten in estimating capital requirements. It must be recognized that when the amount of capital is fixed, a definite limit is set to the capacity for production—a limit to capability to explore markets—in general, a definite limit to the activity of the concern.

Provision must also be made for fat and lean years; and preparation made to weather periods of trade depression and industrial stoppages, and that these require a margin over and above the normal requirements must not be forgotten, and this margin must moreover be provided for in the capital estimates if disaster is to be avoided.

The aim of all business finance should be definitely to maintain the assets of the undertaking at their original value, and the security of capital lies in the ability to do this.

Investment

In the remarks on Planning reference has been made to the importance of planning Investment as a definite element. Investment in an industrial undertaking can be divided into two parts—Fixed and Fluctuating.

In the first must be included Buildings, Plant, and Equipment, all of which are of a semi-permanent nature, and which permanently lock up the capital required to provide them. It must be constantly borne in mind, that these assets, when acquired, represent money on which interest is being paid, and which are able to pay that interest only in so far as they are productively employed. If there are Buildings without Plant and Equipment, the business is being saddled with a charge for which we are not making any attempt to provide. It is therefore obvious that the best results can only be obtained by the utmost use of these elements, and the necessity for appreciating their importance in this respect must be constantly realized.

Fluctuating Assets are stocks of material, work-in-progress, finished stocks, and book debts. Here it is necessary to realize that the money locked up in these

elements represents a large portion of the capital, and whilst so locked up its earning power is indirect or contributory to production. The lower this investment can be kept, the more money is available for the direct purpose of production. Good financial planning will determine the maximum amount of capital that is to be locked up in these elements, and will aim continually to maintain them within that level.

A third important investment is that of development and research, which no modern industrial activity can afford to be without. These represent charges which are not immediately realizable in the form of production. If continued success is to be obtained, the company must be prepared to develop the product, to develop methods and processes, and this cannot be done satisfactorily unless financial provision be made for maintaining a development and research department to be continually engaged on improving the product and the method of its production. This means investment, and which often becomes considerable owing to the lapse of time before the benefit of such improvements can be taken advantage of.

The balance of investment must be kept between the various elements. A certain capacity of plant requires a certain volume of stock to maintain a regular production. The balance referred to should be regular, otherwise the financial starvation of any elements which are deprived of their financial food follows.

Turnover

Consideration must now be given to the financial problem of turnover. Having decided on the capital, we have fixed thereby the total profits which must be earned to pay a reasonable rate of dividend, and

this will enable us, after a consideration of the rate of profit to be expected, to ascertain the minimum volume of business which must be achieved to provide such a dividend.

Again, the ability to produce in a given period from the purchase of raw material to the shipment of the finished product determines to a considerable extent the earning capacity. Remember that the speed of production governs the rate of profit which can be earned in a given time. The amount of that profit can be increased according as reduced investments enable more capital to be devoted to production. Let it then be realized that the period of turnover is the governing factor of the capacity to earn profits and that efficiency in production is a vital factor in determining that capacity.

The volume of business must, therefore, be carefully planned. The maximum volume is obviously the total world requirements for the product. The actual volume up to that limit depends on ability to use the capital at our disposal to accomplish production in as short a time as possible.

It is not sufficient to enter markets with products merely because those markets present themselves. We must determine whether those markets are financially advantageous. In other words, the selling organization must consider the markets from the financial point of view—whether they are sufficiently substantial to support the investment entailed. It is obviously bad policy to lay down an extensive plant to provide goods for a market and to find that that market presents a possible two years of sales only, unless the terms on which sales can be effected will amply repay such an outlay.

This financial exploration of the market is a

necessary preliminary to the determination of price. Price must be governed by the volume of the demand, by the period that demand will continue, and by cost of production. It is essential to realize that cost is not price. Price must allow for varying discounts in different types of markets. To sell against competition may often mean selling under cost. Financial study of markets will enable us to determine where losses can be made up by relatively small price increases in other directions. Price must result in a profit on the whole business, not, of necessity, a profit on cost of a particular unit of the product. The introduction of a new product to a new market may necessitate considerable periods of low price with future prospects of considerable profit. We must also appreciate that in the early stages of manufacturing new products—when we are developing production—cost is not relative to possible price. The financial conditions of the business as a whole must be maintained in a state of profit and that is the important condition.

Profit

The financial results of any undertaking are usually judged from the annual Balance Sheet and Trading Accounts. Balance Sheets seldom show the true financial position; in fact, the only Balance Sheet which can be said to state the true position is the Liquidator's final winding-up statement, and this in successful industrial undertakings will never be written. Let it be recognized that the Balance Sheet is a financial statement primarily designed for the determination of rate of dividend and must be realized as such, and not confused with the information required for the financial control of the business. If we are

content to watch the progress of the business from a yearly Balance Sheet and Trading Account we are not likely to know, between the beginning and end of a financial year, anything about the financial side of the undertaking. The annual Balance Sheet should reflect the overall result of the activities to enable the determination of all the necessary provisions for financial safety, and show the minimum profit made and not the maximum. Let the fact that dividends are desirables and not essentials as a regular thing be kept in mind: that adequate reserves have to be made; and that only after all necessary steps have been taken to ensure the financial stability of the business and to meet all possible contingencies, is a company entitled to consider the payment of dividends.

What are the elements of financial stability? Really they consist of reasonable valuations and adequate reserves for contingencies. The valuation of fixed assets, the valuation of liabilities, and the valuation of stocks, call for the most careful attention. In the case of fixed assets, recognition of the wasting value of assets demands the writing off of depreciation —adequate depreciation—which will enable the whole plant to be maintained in a condition of efficiency, introducing at the right time improved machinery and equipment. Depreciation in itself is a matter calling for the most careful study. The business that does not depreciate its plant to a prudent extent will sooner or later find itself in possession of plant which retards ability to meet competition and will be in consequence on the downward path. The writing off of depreciation is of little use unless it is resolutely used for the purpose for which it is designed.

The liabilities also require careful valuation. Claims must be provided for; undetermined liabilities

considered ; and all eventual liabilities assessed on a safe basis.

Stocks must be depreciated for obsolescence and wastage. Let it not be imagined that 100 sets of parts will make 100 finished articles. Wastage is an important item, and must be properly provided for. Physical stocktaking must be regularly undertaken to ensure the records being correct, while the basis of valuation must represent a true estimate of the realizable value. When all these conditions have been complied with and adequate reserves provided, then, and then only, can the balance between assets and liabilities be regarded as representing profit or loss.

Financial Control

The phase of finance now to be dealt with is that of financial control. Financial information is the only real means of controlling a business. The financial information must be provided in such a manner as to enable the directors of the business to be constantly feeling its pulse and taking its temperature. If financial control is to be effective it must provide all the essential financial information at as short periods as possible. Watch the finance weekly, if possible, and never less frequently than monthly.

The financial control consists of three elements : Learning the lesson of the past ; Knowing what is happening in the present ; and Anticipating the future. The finance controller must look ahead further than any other executive in the concern. Budget as far forward as possible, budget capital outlay ; budget expenditure to a reasonable degree of detail. Avoid getting lost in detail and realize that financial figures are not for the amusement of the

accountant but for the management of the business. Eliminate unnecessary but preserve commercial accuracy; present financial figures in their real perspective; avoid letting thousands go unnoticed and wasting time in pence. The old adage of pence and pounds wants to be intelligently interpreted. In a big business the pounds require taking care of.

Compile the financial returns to enable the business to be studied from a management point of view, and not from an accounting point of view. Provide financial information for each responsible head of a department. Let him see what he is spending and what he is earning. Prepare detailed budgets and set a limit to his expenditure. In this way only can each section of the business be held in financial check and be prevented from damaging the whole structure by extravagance. Remember the foreman—the head of the department—is not a financier, and make simplicity the important aim in presenting figures to the executives.

Cost systems are necessary, but it is important to realize their limitations and their uses. Cost is necessary as one element in fixing price, also as a means of studying efficiency. But the detailed cost which is ready for consideration a month after the event is useless and a waste of time. To be effective cost must be available immediately the operation has taken place. Avoid cumbersome systems which aim at the allocation of every single detail of expenditure. Sectionalize costs so that your executives may see the cost of the element over which they have control, and not waste time examining figures over which they have no control. In all cases the real cost is the total expense of the department against the value of its production. Set a standard of overhead

expenses and keep within it. Let financial figures control waste, seen and unseen. The seen will be a simple matter; the unseen requires keen study with an understanding of the processes and policy of the business as a whole. The search for unbalanced elements of staff and equipment, the determination of economical production, the study of individual efficiency, and overall efficiency, all require keen financial introspection and the presentation of the detailed and broad effect on the financial results of the business, if they are to be effective. Don't imagine you can make financial control effective if the financial staff do not understand the business as a whole. Give them facilities to study it; realize that they require a wide outlook, and a considerable perspective. Realize that to be effective financial control must be up to date and able to put its finger on inefficiency immediately it occurs.

To sum up—financial planning in modern industry is as important as any other function and requires to be realized and studied as an integral part of any business undertaking, it should not be treated as an accounting record but as an essential to successful business. Financial control is capable of regulating the profits of the business to as great a degree as any other phase of the activity.

CHAPTER II

Works Lay-Out and Design

By H. T. Hildage, M.Inst.C.E.

Introduction

Many of the businesses in this country have risen from small beginnings. One or two men have begun to make something or other in a very small way and with very little capital, in some existing building that has probably been selected rather for its cheapness and ready availability than for its suitability for the purpose for which it is used. As a result of their energy, enterprise, and the general excellence of their working, the business has increased, more machinery has been added and perhaps new buildings put up. The new buildings put up have necessarily had to be adapted to the site and to the existing buildings. To some extent the pioneers in these industries, on account of their shortness of capital and for other reasons, have been limited and bound by conventions that have grown up or that existed in their particular line. One result of the growth uncontrolled and unguided, or rather, controlled and guided by considerations that are foreign and perhaps inimical to the actual needs of the business, is that we find many manufactures are unsuitably housed. The work is very often carried out in buildings that have never been designed for the purpose to which they are put, and that the growth of the business has rendered inadequate, and improvements in methods have rendered obsolete.

Both buildings and site have been selected, not exactly haphazard, but not as site and buildings should be selected, with only one thing in view, viz. : their suitability for the purpose for which they are used.

A great deal of thought and care and enterprise has been used in improving machinery, methods and processes of manufacture during recent years. This work has been very fruitful indeed, but this very fruitfulness has added to the difficulties of the situation already mentioned, by increasing congestion and difficulty of handling and working. Great strides have been made in improving methods of transmitting and distributing power, and a great deal of this progress has been made within the lifetime of the vast majority of existing buildings. So that, generally speaking, the British manufacturer is suffering from a handicap which, notwithstanding the fact that it is in no way due to his carelessness, neglect, incompetence, or lack of enterprise, is a very serious handicap. Most of his competitors abroad have entered the business at a later date, and have been able to learn a good deal from him, whilst avoiding some of the errors that he was unable to avoid. It is very seldom indeed, for example, that a manufacture is commenced in the United States without ample capital to purchase a site specially suitable for its purpose and to erect thereon buildings specially designed with the single view to their suitability for the manufactures, and to take advantage of all the latest and best methods and appliances for use in the industry. It will pay manufacturers in this country to study this whole position very carefully indeed, whether they are contemplating the laying out of a complete new home for their industry or not—it will be time and labour well spent to consider what would be an ideal lay-out

for their factory. This ideal lay-out having been prepared, it will be possible to compare it with their existing lay-out to see how far, if at all, their existing works can be assimilated to the ideal works, and to form some kind of an estimate of the advantage of making this assimilation. In any case, the study that is proposed could not fail to result in some improvement of great value, even if it falls very far short of resulting in the building of an entirely new factory.

For the purpose of this chapter then, it will be convenient to assume that it is proposed to establish a manufacturing concern, and that all the vital factors and statistics necessary have been obtained as the result of experience as well as a detailed and expert knowledge of all the processes of manufacture, and of all the machinery that is required for carrying them out. It is assumed, for example, that the output of the proposed plant is fixed, and that it is known what it will cost to distribute this output as regards freight charges and packing costs. It is known what weight or bulk of raw material is required for this output and what are the sources from which this raw material can best be obtained. The value of the raw material per unit of output is known, and also the cost of labour and the cost of power per unit of output.

There has been drawn up a complete list of manufacturing processes commencing with the writing of the works' order and finishing with the invoicing of the delivered product. A complete list of machines, tools, and other plant for the carrying out of these processes is available, with the number of each item that will be required to produce that output.

There has been assumed a sum of money that can

be considered available for the purpose of acquiring the new site, putting up the new buildings, and completely equipping the factory with all the required machinery and handling appliances.

With all this knowledge—what is our problem? It is—

(*a*) To decide which is the best district in which our factory or works, or, as the Americans say, "our plant," is to be located.

(*b*) To decide within that district to state our requirements as regards site, in size, shape, and topography, and to decide of all available sites, which is the best.

(*c*) To decide with the single view to the utility for the purpose under discussion what are the best kinds of buildings to put upon the site as regards size, shape, type, and method of construction, and how they are to be lighted, heated, and supplied with power.

(*d*) To fix upon the positions of the machines within those buildings, having in view the receiving of the material into the building, the handling of it through all the various processes, and the delivery of the finished product.

(*e*) To decide in the same way how the buildings shall be placed on the site in order that the raw material may be conveniently and economically received, if necessary, put into stock, and handed from the receiving point or from the warehouse to the various manufacturing processes—and the finished product, in turn, conveniently and expeditiously sent away to the markets by road, railway, or water.

(*f*) Having made all these decisions and having obtained a plan that can be considered ideal, or

approximately ideal, to get out a careful estimate of the cost of carrying it out and see how this estimate compares with the sum of money available—if it exceeds it, to decide whether the additional sum can be obtained or is worth while. If not, to decide what modification in the plan can be made with a view to bringing this cost within the sum available with a minimum loss of efficiency of working.

The solution of this problem necessarily involves a careful consideration, amongst other things, of all available methods of handling materials, and a selection from amongst these methods of those that are most suitable for our purpose.

Selection of Location

Generally speaking, the things to be kept in view, both in selecting the location and in selecting the site, are the proximity of the market, the proximity of the raw material supplies, the availability of suitable labour, and the availability of railway accommodation, road transport, and power supply. The influence each of these factors will have on the decision will vary according to the nature of the industry that is to be carried out—all of them must be carefully considered and allowed for.

In some industries, it is possible to say at an early stage that one of these factors transcends all the others in importance to such an extent that the others can be relegated to a very secondary place—*e.g.*, if the cost of labour in the finished product constitutes by far the greater proportion of cost, then obviously the obtaining of a good supply of suitable labour is the most important question, and it will be necessary either to locate the factory in a district where the right kind of labour is readily available, or to create,

in some district that does not already contain it, a suitable supply. This can be done and is done in certain cases by the provision of suitable and attractive housing accommodation for the workpeople, and generally by making the district an attractive place for the people we wish to employ to live and work in.

In any case, even if the labour only forms a small proportion of the cost of the finished product, it must always be borne in mind that labour is essential, that the industry must be made attractive to the workers, and that, without happy and contented workers, it is impossible to carry on satisfactorily and economically any industry.

The question as to whether it is better to locate the factory in close proximity to the markets, or in close proximity to the supplies of raw material, will depend on the relative values and weights of the raw material and of the finished product and the cost of transportation—this cost including, of course, for this purpose, the cost of packing and of handling. This can well be illustrated by taking a very extreme case—suppose it is desired to extract gold from an ore containing, say, 3 pennyweights of gold per ton of ore; nobody would ever think of establishing such a works as this anywhere but on the mine, because the finished product, viz., the bullion, is relatively so small in weight and bulk that its transportation will be insignificant, and, although the remarks made above with regard to labour still apply, this is one of the cases where the labour will have to be taken to the job instead of the job being taken to the labour. There is probably no case where this condition can be exactly reversed, that is to say—the finished product will always be less in weight and bulk than the raw material, but we might have a case where either the

raw material is relatively insignificant when compared with cost of labour, or where the cost of labour is very low when compared with the cost of raw material, or the raw material may come in almost equal quantities from two or more sources far distant from each other. It is assumed, therefore, that in deciding on the district in which the works is to be placed, we have proper statistics as to the source, cost and weight of raw material, the cost and weight of the finished product, the cost of labour per unit of manufacture, and full information as to the cost of transportation to and from any proposed district of raw material and finished product.

In making the decision with this data before us, we shall necessarily have in view the probable trend of prices, both of raw material and the finished product, and the probable or possible changes in the cost of transportation.

In the same way, the relative importance of proper railway accommodation and road transport and power supply will vary with different industries. It may be, for example, that in a particular case the location of the industry will be fixed solely by the proximity of supplies of fuel or power. An example of this (another extreme case) is the extraction plants of the Aluminium Co., which are located in the neighbourhood of natural sources of power. Generally speaking, however, the presence or absence of road and railway accommodation will not *determine* the location of the factory within these islands, and the long distance transmission of electric power by high tension lines has reached such a stage of development that the influence of this factor on the selection of the location will not usually be a preponderating one.

SELECTION OF SITE

These selections are being dealt with in the order in which they will usually be made, but obviously the size of the site cannot be determined until the size and number of the buildings to be erected upon the site have been fixed, and these decisions, in turn, will depend upon the size and number of machines that they are to accommodate, as well as upon other considerations which will be mentioned later. Assuming, however, that an ideal lay-out has been prepared for the site, with the knowledge just mentioned, it will be easy to decide whether any available site is suitable for the purpose or not as regards size and shape.

The character of the industry under consideration will decide whether it is essential that there should be actual railroad accommodation in the site. A comparison between two sites, one of which has direct railway access and the other has not, can always be made when the weight or volume of the daily output is known, because the cost of road haulage to the nearest railway goods station can be pretty closely estimated.

The general contour of the ground and the relative level between the ground and adjacent railways or roads will have a very important bearing upon the cost of carrying out the scheme.

In the same way, the presence of any streams in the neighbourhood that may overflow their banks and thus cause flooding will be an important consideration. If there is a good deal of filling to do, either to make the ground level or to raise its general level, so as to bring it nearer to rail or road level, or to raise it above flood level, there will be to consider, not only the cost of the filling, which may be

very considerable on a large area, but also the additional cost for foundations which will have to be carried through the filling to solid ground.

Other matters that require to be provided for are sewer connections for drainage purposes, water supply, supply of power, and, in some cases, a supply of gas.

Great care must be exercised in selecting a site which is liable to have the minerals worked from underneath it. If the minerals are at a great depth, and are fairly carefully worked, there will not be much danger from uneven settlement, but general settlement will usually occur, and this must be borne in mind in connection with the liability to floods. On the other hand, if minerals that are close to the surface are worked, local and uneven subsidences are almost certain to take place, and to result in a complete disorganization, if not disintegration, of the buildings. In the case of an extremely desirable site, of course, this can be met by purchasing the minerals under the site, and thus preventing possibilities of subsidence.

Due account will naturally be taken, in comparing two sites, of proximity of a railway station or housing accommodation for workpeople, and it will add to the value of the site if facilities are available in the neighbourhood for the workers to obtain their mid-day meals at reasonable prices, without the firm having to provide canteen facilities. It is rather questionable, however, if capital is available, whether it is not advisable to provide these facilities, whether otherwise available or not. It is generally considered profitable to provide the workers with, at any rate, the opportunity of purchasing their meals at the bare cost of food, together with a comfortable place to take their meals and reasonable facilities for recreation.

The last, but decidedly not the least, is the question

of the cost of land. If sufficient land is available at a reasonable price to provide for future extensions, this should be taken up and the character of those extensions should be decided, as far as possible, beforehand, so that when they come to be made, they shall not be made haphazard to suit the emergency of the moment, but shall be part of a carefully thought out and well ordered scheme. Any land in excess of immediate requirements that is taken up in this way can very advantageously be handed over to the workpeople for allotments or recreation purposes.

Buildings

The size and shape of any building will be determined by the number of processes that it has to accommodate, and the size and shape of the machinery and other plant that is required for those processes. Naturally before fixing the size and shape of the building, we shall have to prepare a list of all the processes that it has to accommodate, and to draw up a schedule of the number of machines or other plant required for each process. We shall also have to prepare a preliminary lay-out of the departments in which each process is carried out, deciding carefully at which point in the department and by what means the material enters, at which point in the department and by what means the product leaves, and what space is necessary within the department for departmental stores, stocks of materials, stocks of finished parts or product, and also what space is necessary for inspection of finished product, because it is assumed that the work done at each process will be inspected and passed before the material or product goes on to the next process. I do not wish to anticipate what will be said by others on inspection, but, generally

speaking, it can be taken that the sooner the inspection takes place after the process is complete, and the nearer to the point at which the process is actually carried out geographically, the better will be the result—not only as regards the quality of the product but also as regards the reduction of waste, and the actual amount of output.

This preliminary study will tell us how much clear space we require for each process and will give us some idea of the shape of that space. In deciding on the final size of the room, we ought to provide some space for extensions in each department. After the buildings are completed and manufacturing is proceeding, it is almost inevitable that we shall find some processes out of balance with some others, and, in order that production may be as nearly uniform as possible, we should naturally wish to bring up to the standard of the remainder, the production of those departments that are lacking.

In addition to this, it is almost certain that we shall from time to time improve the processes of manufacture in the various departments and, in order that we may be in a position to take full advantage of these improvements by increasing the total production of the plant, we ought to have some room for extension of plant in each of the departments not so improved. The whole of the extension space thus provided can be put down to the balancing of the plant.

The height of the room will be determined on other considerations, one of the most important of these being lighting. It is impossible to exaggerate the necessity of obtaining an adequate supply of natural lighting. It is not merely essential for the health, comfort, and well-being of the employees that they

should work as far as possible in natural light, but it is essential for the proper carrying out of all manufacturing processes that the utmost possible use should be made of daylight.

It is also a well established fact that freedom from accidents depends on adequate lighting being provided. Statistics carefully taken in manufacturing plants show that the difference between the number of accidents in the darkest months and the number of accidents in the lightest months, amounts to as much as 80 per cent. of the latter.

In a single storey building, of course, roof light can easily be obtained, although this may to some extent be interfered with by overhead gear such as cranes, transporters, and power transmission appliances. This statement requires to be qualified by a warning against excessive glare and heat, especially in the Midlands and South.

In a multi-storey building, the only light available will be side light, and this, in itself, will have some effect in fixing the relation between the height of the room and its width. Generally speaking, assuming that adequate window space is provided, and by adequate window space I mean that practically the whole of the side of the building, apart from the space taken up by structural necessities such as columns, is window space, a good relation between height and width is about 15 ft. height to not more than 55 ft. width. The illustrations Fig. 1 and 2 show cross section and plan of a multi-storey building with a light well and give *maximum* widths and *minimum* heights of rooms, together with *minimum* dimensions of well for efficient lighting.

If overhead cranes and transporters are used, sufficient clearance will be required underneath them

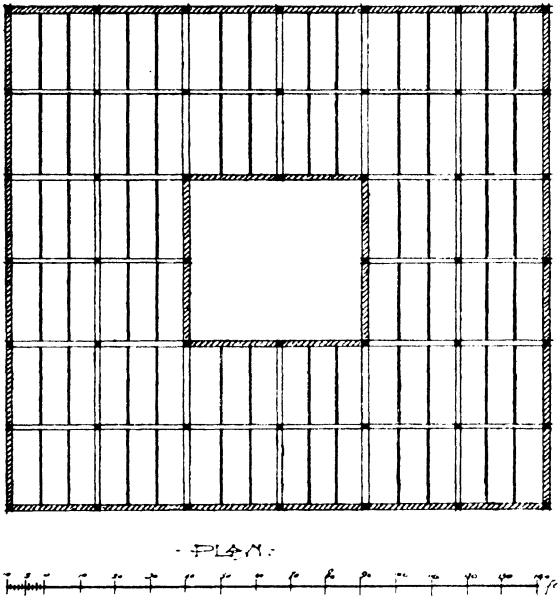

FIG. 1

PLAN OF A MULTI-STOREY BUILDING
WITH A LIGHT WELL

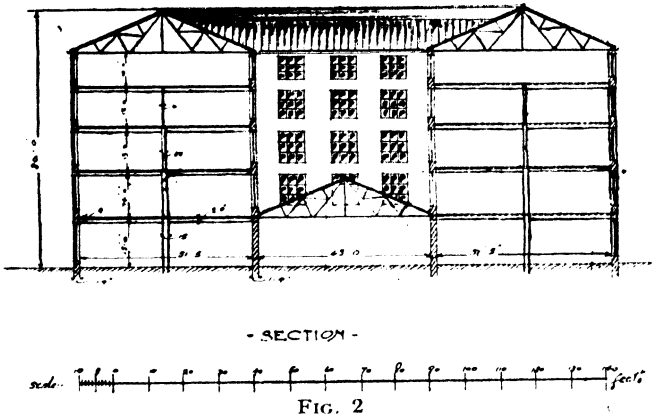

FIG. 2

CROSS SECTION OF A MULTI-STOREY BUILDING
WITH A LIGHT WELL

to prevent any possibility of moving mechanisms or loads fouling anything standing on the floor of the room, and this, in itself, may cause us to fix the height of the room at a higher figure.

Having decided roughly upon the size and shape of the floor space required, we are in a position to consider whether we will have a single storey building or a building of several storeys.

Obviously a building of several storeys is more economical of land, and, if our factory is located in a district where land is expensive and valuable, this will be an important factor tending towards a decision in favour of a building of several storeys.

Generally speaking, single storey buildings will be avoided in or near cities on account of the costliness of the land, but the proper way to make a decision as to which is the more costly in a particular case is to prepare preliminary and approximate designs and obtain approximate estimates of cost. There is no doubt that single storey buildings render it easy to obtain efficient natural lighting because, if necessary, the whole expanse of roof can be made of glass and, just at the moment, glass is about as cheap a roof covering as can be obtained.

On the question of supervision, opinions will probably be rather divided. It will be easier to overlook the work if the factory is housed in one large single storey building. On the other hand, it will not be so easy to prevent the employees from wandering beyond the limits of their own departments, and it will be more costly to prevent them escaping from the building altogether, on account of the fact that there will necessarily be many entrances in a large single storey building as against one only in a multi-storey building.

Generally speaking, better and less costly arrangements could be made for moving material and products from one department to another in a single storey building. For this reason, if the cost of land is so high that we are compelled to use buildings of more than one storey, we must consider very carefully the method of transferring the material and work from one floor to another, and these methods should be decided upon before the design of the building is proceeded with.

In certain cases, the nature of the work to be carried out and the character of the product will preclude the use of multiple storey buildings.

For instance, structural steel work, bridge work, and very heavy engineering work has not, to any great extent, been carried out in multi-storey buildings on account of the size, weight, and general awkwardness of the pieces to be handled. It is not, however, impossible that their use might be extended even to such classes of work as these. There are examples in the United States of manufactures consisting principally of cast iron being carried out in a four or five storey building with the foundry at the top and the machine shops in the lower floors, and, provided the question of handling the material up and down is carefully considered beforehand, there is no reason why this should not be done. It is perfectly easy to design mechanical elevators for raising pig iron, fuel, sand, and other materials to the top of a four-storey building, and to design mechanical means of lowering the castings into the lower storeys. In considering matters of this kind, as, indeed, in considering the whole question, it is wise to take nothing for granted, to consider no obstacle as insuperable, to question and criticize every conventional method of

doing a particular piece of work, and to do this in the light of the best information you can obtain as to the most modern methods of handling material.

It will be easier to keep a multi-storey building at a comfortable temperature, and this is a most important consideration in relation to output. It is impossible for workers to give their best output if the building they are in is either too hot or too cold. In the same way, if artificial ventilation is resorted to, it will generally be cheaper for multi-storey buildings than for single storey. On the other hand, of course, any amount of natural ventilation can be readily obtained in single storey buildings by means of roof ventilators, but this is often wholly unsatisfactory.

The methods of power transmission used will not be materially different whether the buildings are single or multi-storey, but will depend rather on the nature of the processes to be carried out and the character of the machines used.

As far as single storey buildings are concerned, there is really only one type of construction that need be seriously considered, and this is a steel frame building with the sides enclosed with brick work, corrugated sheeting, or concrete slabs or blocks. It is not possible to say a great deal about these different kinds of casings, except that corrugated sheeting is at present just about as expensive as the other methods and much less permanent. In a multi-storey building, however, we may have—

(*a*) A steel frame with brick walls simply to enclose the sides but not carrying any load, and concrete or wooden floors.

(*b*) Brick walls to carry the loads with steel and concrete floors.

(*c*) Buildings constructed entirely of reinforced concrete, either of monolithic structure or of unit and precast construction.

As far as cost is concerned, the competition at present will generally be between the first and last of these three types. Generally speaking, at the present moment there is not a great deal of difference between the cost of steel frame and the reinforced concrete buildings. A well-organized firm producing reinforced concrete buildings with up-to-date handling appliances and shuttering standardized as far as practicable, may produce a cheaper building than a structural engineering firm that is not properly organized and laid out for this class of work. On the other hand, reinforced construction should not be considered unless it is intended to employ a thoroughly experienced and well-organized firm of contractors with a good reputation for carrying out this class of work. There is much more danger from carelessness, neglect, or dishonesty in a reinforced concrete building than in any other type of building, but this, in itself, is not a sound argument against the type of construction. The safety of the reinforced concrete structure is dependent upon the quality of the material used, and especially upon the skilful handling of the mixing and placing of the aggregate and the placing of the reinforcement. Want of knowledge or want of experience on the part of the contractors, and want of skill and want of care on the part of the men fixing the reinforcement and placing the aggregate, will endanger a structure, even if all the materials are of the very best quality. Probably most failures in reinforced concrete construction are due to carelessness and want of skill and knowledge, and the only way to guard against these factors is to employ only

thoroughly reputable and experienced firms in this class of work, and to see that there is proper supervision at every stage.

These arguments apply, of course, to any type of construction, but with considerably less force. In a steel frame building, assuming that the material is of good quality to begin with, there is very little opportunity for failure as the result of carelessness or scamped work.

There are two considerations that seem to tell rather considerably in favour of steel construction. In factory buildings, it is very frequent indeed that alterations in design are made after the work has commenced, and these can be carried out much more readily in steel frame buildings than in reinforced concrete buildings. Indeed, alterations in concrete buildings are often practically impossible after construction has commenced. The other consideration is that of speed in erection. It is dangerous and often impossible to hasten the erection of a reinforced concrete building, and, generally speaking, the time is considerably greater than the corresponding period for a steel frame building.

It has happened in the case of a very valuable site that the rent of the site for the difference in periods of erection of the two types has been sufficient to make it cheaper to use a steel frame building than a reinforced concrete building. It is, of course, not often that very expensive sites are used for factory buildings; but, on the other hand, it is a very important consideration to a manufacturer once he has decided upon putting up his building to get the use of it at the earliest possible moment so that his manufacturing may begin.

The only sure way to make a decision in a particular

case between these two methods of construction, is to have competitive designs prepared by firms specializing in each of these types of construction immediately the dimensions and type of building are decided upon. These designs should be carefully costed and resulting estimates compared. It may very well be that the dimensions of the building alone will rule out one or other of the two types of construction.

Lay-out of Buildings

As has been stated already, preliminary lay-outs should be prepared for each department before deciding upon the size, shape, and type of the building. The conditions that will govern these lay-outs are the size and shape and method of driving of the machines, the number of machines, the method of feeding the machines with material, and removing finished parts, as well as what may be called the auxiliary places in connection with the department; viz., supervision, the inspection and stores of material, appliances, and product. The question of lighting must also be carefully considered in connection with the placing of the machines, especially with side lighting, as in the case of multi-storey buildings.

The man in charge of a department should be isolated and yet with easy access to the work he is supervising—isolated in order that he can give thought and care to the discharge of his routine duties without being liable to frequent interruption, and, as far as possible, protected from the noise. When it is possible, a very good plan is to have the foreman in a glass box as nearly as possible in the centre of his department and raised a little above the general level of the floor, so that he can see every portion of his department by merely turning his head.

When the departments have been laid out in this way, each as a unit, they can be fairly readily assembled together, and the means and the method of communication between them be decided upon.

As far as possible, the area covered by a department should be well defined and clearly marked so that a foreman, who is well acquainted with each of the employees under his supervision, can recognize at a glance any stranger who enters his department, and readily decide whether the visit is a legitimate one or not. The entrances and exits to his department should be under his eye, so that he may observe the coming and going of his employees.

Lay-out of Site

When the site has been selected, and the number, size, and design of buildings to be erected upon the site are decided upon, a large scale drawing of the site should be prepared showing position of the railway access and position of the road access, and where the site is not a level one and is not intended to remain level, sections should be plotted to an exaggerated scale. Then the process of laying out the site will be similar to the process of laying out the buildings, the things to be considered being the point at which goods arrive, and at which the finished product leaves the works, the point at which the workpeople enter and leave the works, the positions of offices for checking the arrival and departure of people, and the arrival and departure of goods; the unloading point; the position of stores and stock yards for raw material; the lines of communications between these and the buildings in which the raw materials are used; the positions of the buildings in which the processes are carried out, bearing in mind the possibility of interruption

of light; the lines of communication between the various buildings; the despatching point and the line of communication between the buildings and the despatching point, which will, of course, be somewhat in the neighbourhood of the warehouse, or the point at which the finished material leaves the last process.

It is not possible in a general statement of this kind to say very much that is definite either about the laying out of buildings or about the laying out of sites. What can be said is that, generally, lines of communication should be perfectly definite and as short as possible, should provide ample accommodation, and should not, if it can possibly be avoided, cross one another, so that there may be no confusion and no congestion. They should be so laid out as to reduce the handling as much as possible.

In considering the whole of this question of Works Lay-out, the ideal that is kept clearly in view throughout should be "Continuity of Operation." As far as possible, from beginning to end, there should be a continuous flow of work and material from the entrance to exit. This, of course, is an ideal that will hardly ever be realized, but it is an ideal that should always be kept in mind and, as far as possible, approached. Intermittent operation inevitably means increased handling, and increased space for storing and stocking, and whilst these cannot, of course, be altogether avoided, they should be reduced as much as possible from the point of view of handling alone. Obviously, the best plan would be for the material to pass substantially in a straight line—in most cases, however, this would give a site in which the entrance and exit are very long distances apart, and this is undesirable for other reasons; but usually it will be possible to arrange that the material passes along a

perfectly clear, definite, and continuous line, without crossing or interruption, and still have the point of entrance and the point of exit within reasonable distance from one another.

Where the ground has a natural gradient, the question of moving material by gravitation should be considered, especially where the material is of a weighty character.

CHAPTER III

Works Transport

By H. T. Hildage, M.Inst.C.E.

It is now proposed to refer more particularly to a few of the modern methods of Works Transport, and to make passing references to the more familiar and conventional methods and appliances.

In considering transport in a new factory or works, there are several points that should be carefully borne in mind from beginning to end. In the first place we should never accept, without question, a conventional method of handling material. Conventional methods are almost invariably hallowed by antiquity. Many of them are capable of replacement by much better methods of more recent design, and some of them (however justifiable and wise their use may have been at the time they were first decided upon) are now completely obsolete and should be superseded without any delay. Their use in a new factory may be entirely unjustifiable and indeed inexcusable. In laying out a factory, advantage should be taken of all the experience of which information can be obtained, not only in our own line of business but also in other lines of business. Scrutinize carefully all existing methods of handling material and of transport and select from them those that are most adaptable to the particular problem.

Secondly, bear in mind carefully the primary function that is to be discharged by each instrument of transportation and maintain a strict proportion between that function and any subsidiary functions that the

instruments may be required to discharge. What is meant is this—there have been developed a number of more or less composite or general utility tools, which have been generally used when a tool of single utility specially designed for the purpose would have been much better, with resulting inefficiency and high cost in handling. The whole art of repetition manufacturing depends upon a wise and judicious subdivision of processes, with specially designed instruments and tools for each. A tool specially designed for a single purpose can always be made much more efficient for that purpose than a composite tool capable of carrying out two purposes can be designed for both of those two purposes.

Take an example—a portable steam crane is an excellent instrument for lifting a weight, transporting it a short distance by slewing the jib, and lowering it into a new position. Such a crane is probably as efficient a means as can be found of discharging goods from a barge on to a wharf, or from a railway wagon into a yard, provided the crane and the barge, or the crane and the railway wagon are brought so close to the point at which the material is required to be placed that the only motions the crane has to make for each piece of material transported are lifting, slewing and lowering. The crane is made portable, not so that it can be used to lift a piece at one point, transport it to another and then lower it, but so that it can be brought to the point at which it is required to discharge its primary function, namely: the lifting and lowering of material. A five ton crane of this type will weigh somewhere between 22 and 27 tons, so that in transporting 5 tons of material 100 ft., by such an instrument, we actually move a total of between 27 and 32 tons

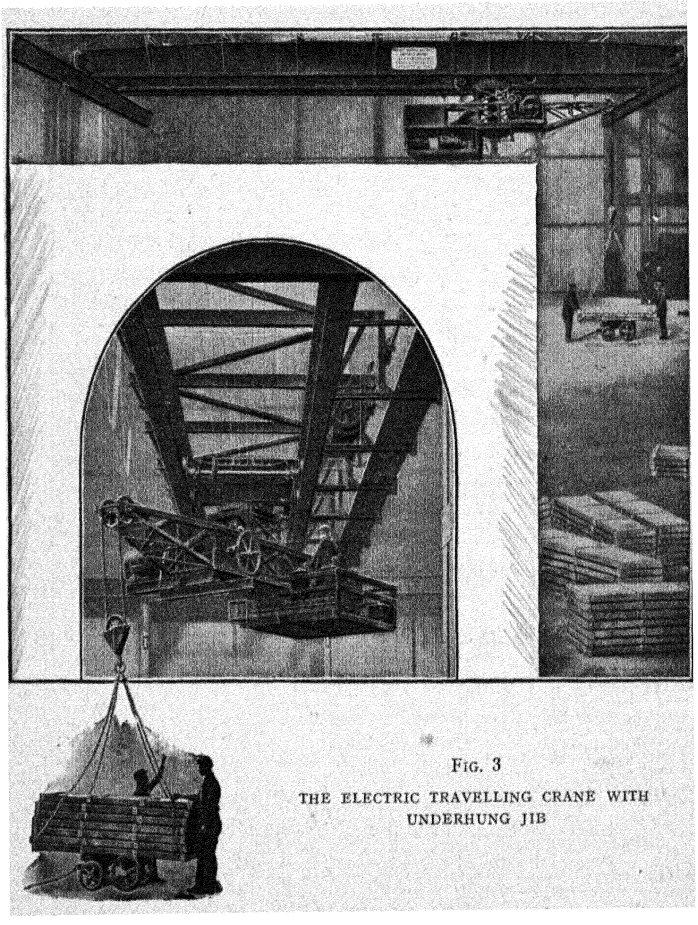

FIG. 3

THE ELECTRIC TRAVELLING CRANE WITH UNDERHUNG JIB

100 ft., and from 22 to 27 tons, another 100 ft., so as to bring the empty crane back to the starting point. The wastefulness of this process is obvious from this statement, apart from the fact that the rate of motion in transportation is necessarily very slow.

For general work, tools of general utility are necessary but, as has been stated, the whole secret of economical manufacturing in large quantity, is the designing of special methods and special tools for each individual process.

The third thing to remember is that the ideal to be aimed at is " continuity of operation " and, therefore, continuous methods of transporting material should always be sought. If material is being moved from "A" to "B" and the transporting instrument has to return along the same route in order to take up another load, it means that the transportation is necessarily more intermittent than it need be. Therefore, one road for going and one road for returning empty should always be provided, unless it is possible to obtain a method of transporting in which no return journey is necessary, and very often it is possible.

Having laid down these three principles, we can proceed to discuss the various methods of transportation available, and for this discussion the problem may conveniently be divided into two—vertical transport and horizontal transport.

Vertical Transport

Amongst instruments for vertical transport, the most common are, of course, cranes. The various types of cranes available are probably so well known that it is not necessary to say anything about them. The exception to this is the Electric Travelling Crane with an underhung jib which is exceedingly useful

in certain cases. (Fig. 3.) It enables goods to be handled to points outside the gantry on which the crane is running, and this is very useful for loading up wagons, for reaching from one bay of a building in to adjoining bays, or from loading into barges from a shed lying either end on or side on towards a dock. The only other comment which need be made about cranes is that they are very frequently abused, being designed primarily as lifting instruments or for vertical transport and, as their locomotive function is a subsidiary function and only given to them for the purpose of bringing them into proximity with their work, it is an abuse to make this locomotive function their primary function and results in expense, loss of time and discontinuity of operation.

Another instrument for Vertical Transport is the hoist or, as the Americans prefer to call it, the Elevator. On account of the fact that having lifted a certain quantity of material the hoist must necessarily return to obtain another load and must return by the same route, it is discontinuous in operation, and to this extent inefficient. This discontinuity can be reduced by having several side by side working on the same duty. It has one advantage over cranes, however, and, to my mind, it is a considerable advantage. It cannot be abused by being used for horizontal transport—it can only discharge its primary function, viz: lifting and lowering: and, in consequence, it usually discharges that function more efficiently (taking things all round) than a crane.

Wherever possible, following the ideal of a continuous flow of material, continuously acting elevators should be considered, and wherever a problem in lifting arises, for the solution of which it might be possible to obtain a continuously acting elevator,

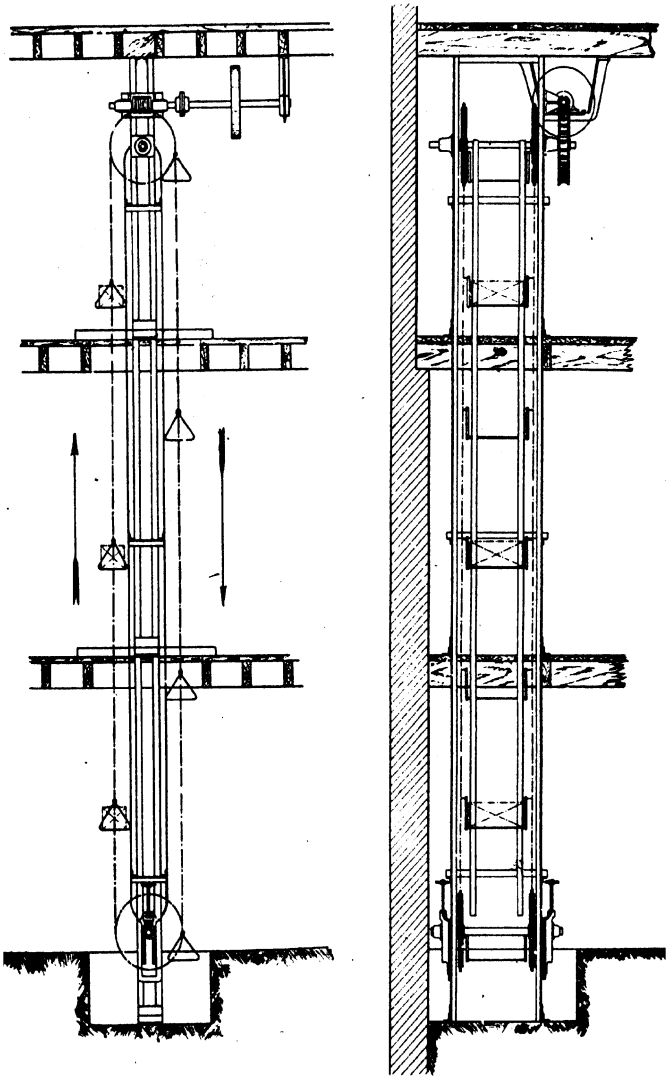

FIG. 4

SWINGING TRAY ELEVATOR

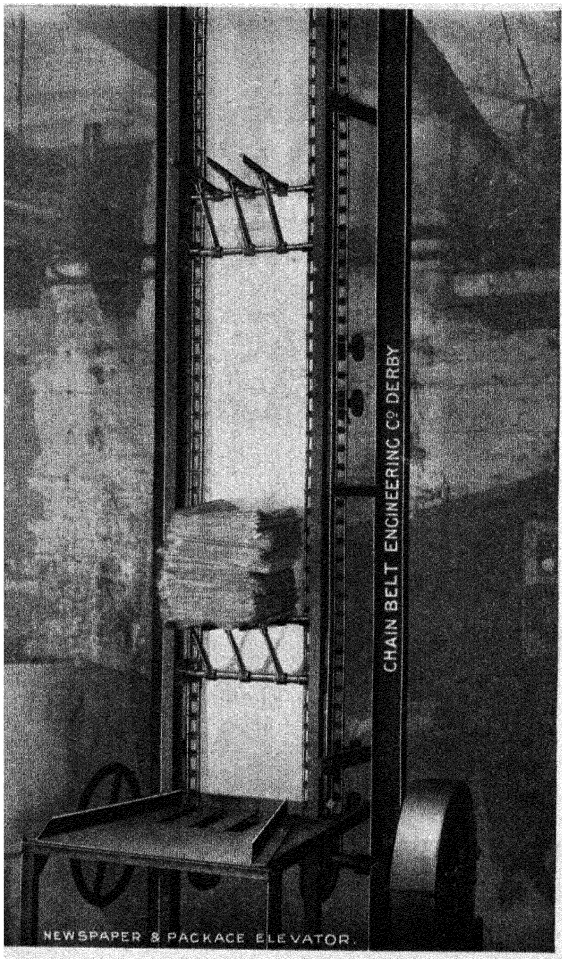

FIG 5.
RIGID ARM ELEVATOR

the services of some firm skilled and experienced in the design of this kind of plant should be sought, and a solution of the problem should not be abandoned until it is definitely shown that it cannot be solved by this means. So many wonderful things have been done in the direction of lifting material both by loose

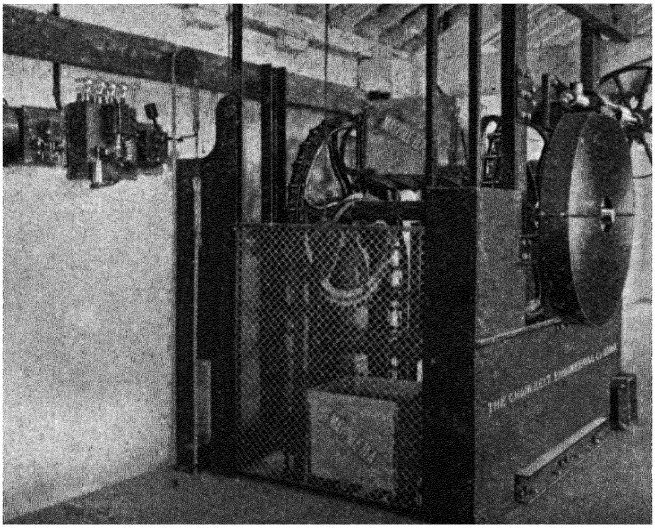

FIG. 6
FINGER TRAY RAISING TEA CHESTS

material elevators, handling such material as grain, coal, coke and earth, and also by elevators specially designed to handle packages and pieces, that one gets the impression that no problem is really impossible of solution by this means. A few illustrations of elevators of this kind are here shown and are taken from cuts kindly lent by The Ewart Chainbelt Co., Ltd., Derby.

For lowering material, of course, gravity can quite

often be efficiently and effectively used. If the vertical transport is in a multi-storey building, the raw materials may be carried up either in continuous elevators, in hoist or by means of cranes, and brought down again by gravity from floor to floor and from process to process, either by the same means or by slides or shutes either straight or spiral specially designed for the purpose. The principal difficulty would usually be in designing an

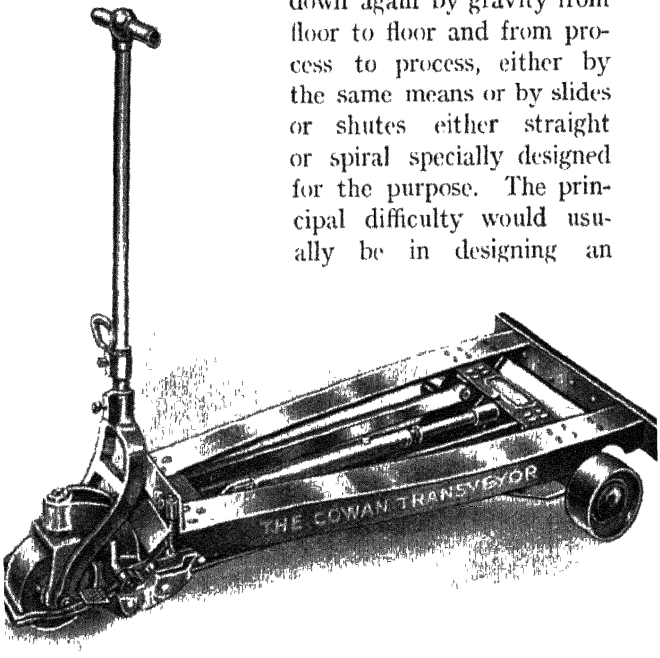

FIG 7

automatic means of charging above and clearing below.

HORIZONTAL TRANSPORT

The simplest method of horizontal transport is the "truck" and considerable progress has recently been made in the design of trucks. The trucks may run

either on the floor without any fixed track or with a rail either of narrow gauge or of ordinary railway gauge according to the size and weight of the material to be transported. For ordinary light transport about a shop, without the need for fixed tracks, that

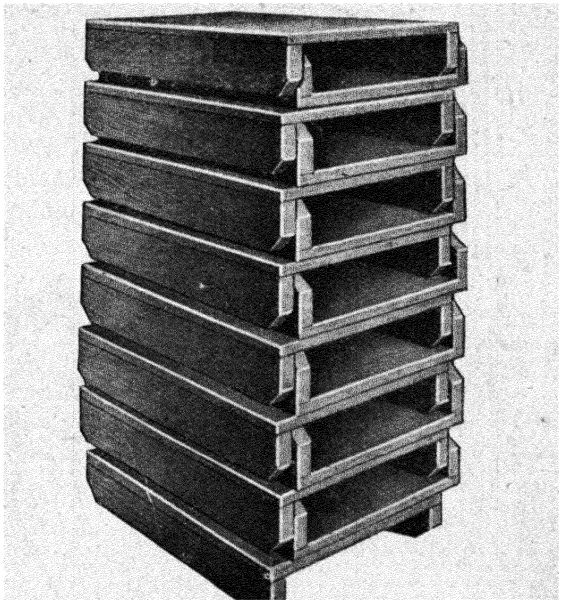

FIG. 7A

SKIDS FOR TRANSVEYOR

is to say—to carry a load up to say 2 tons, and of ordinary bulk, a truck of the type shown ; viz. : the "Cowan Transveyor" takes a good deal of beating. This truck consists of a three wheeled bogie on ball bearings, the body of which can very readily be elevated and lowered—this bogie is the locomotive portion of the appliance. For each bogie a certain number of skids or decks are provided as shown in

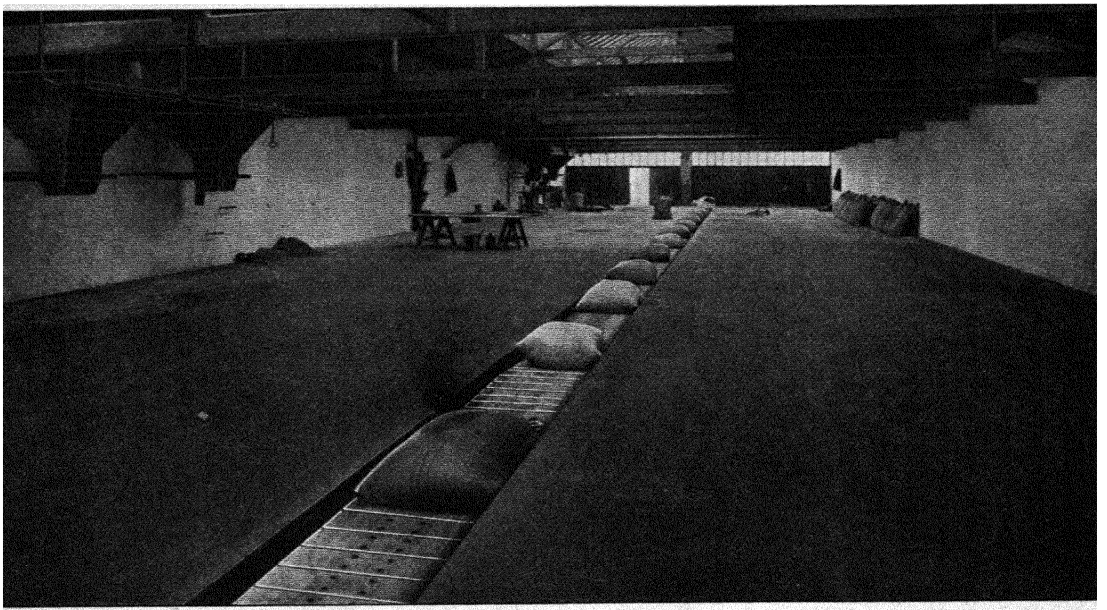

FIG. 8

SLAT CONVEYOR HANDLING BAGS

the illustration, and the material is loaded up on these decks. When it is desired to remove the material, the bogie is run in under the skid, the skid is then lifted by a simple movement and the whole load can be freely moved.

It is possible that trucks of this character will entirely supersede the narrow gauge shop railway hitherto used—the fact that one is able to obtain smooth and easy motion by the combined effect of broad wheels running on smooth floors with ball bearings, rendering the rails in most cases entirely unnecessary, and making the contrivance more generally useful. For heavy loads, there are a number of very good self-propelling vehicles—the motive power usually being electricity, given from Storage Batteries.

Another method of horizontal transport that has been largely developed of late years is the continuous Conveyor. Band and trough conveyors are very extensively used for loose materials, such as coal, grain, ore, sugar cane and so on, and they are, of course, continuous in operation. In the same way that it is possible to design package elevators, it is possible also to design package conveyors principally of the slat type and an illustration of one of these by The Ewart Chainbelt Co., Ltd., is shown.

The advantage that conveyors of this kind have over trucking is that they are continuously acting at a higher rate of speed than the trucks can move, and the only attention they require is the loading at one end and the clearing at the other. The disadvantage, of course, is that they are rather limited in their scope since there is a limit to their length, and they cannot turn corners without multiplication of conveyers, and also they often occupy floor space.

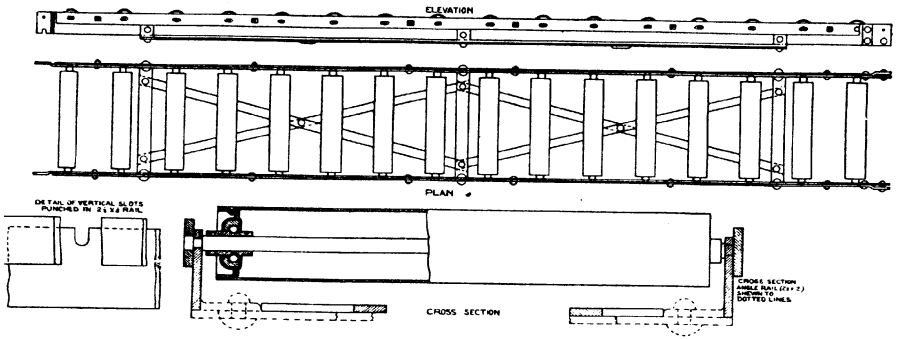

FIG. 9

GRAVITY CONVEYOR

It must be remembered, however, that there is no necessity to provide a return track—the conveyor is really an endless belt.

Generally speaking, these conveyors are specially designed each for its specific purpose and the charging and discharging mechanism is also specially designed, and there does not seem to be any limit to their possibilities. There is another kind of conveyor, however, that has recently come into fairly extensive use and it has many advantages—it is called "the gravity conveyor" and consists of a series of rollers mounted with ball bearings on spindles that are attached to side frames (see illustrations). The frames carrying the rollers are mounted on legs or hung from ceilings in such a way as to be either perfectly horizontal or with a very slight declivity, in the direction in which motion is desired. This declivity varies, when automatic motion is required, between 2½ and 4 per cent. according to the size and weight of the pieces to be transported. Anything can be conveyed on these conveyors that has one flat surface, switches can be provided so that the material may move from one track to another, and curves are made so that it can turn corners; no motive power is required for this conveyor and it automatically comes into operation when it is required—that is to say, when a piece or package is put upon the conveyor, it automatically begins to move towards its destination at a moderate pace, and requires no further attention until it gets there. In the case of a line of conveyors being used to feed with raw material a certain batch of machines, it is often convenient to provide two conveyors, one above the other. The raw material comes in on the lower conveyor and lies there until required, and finished work is placed upon the upper conveyor and

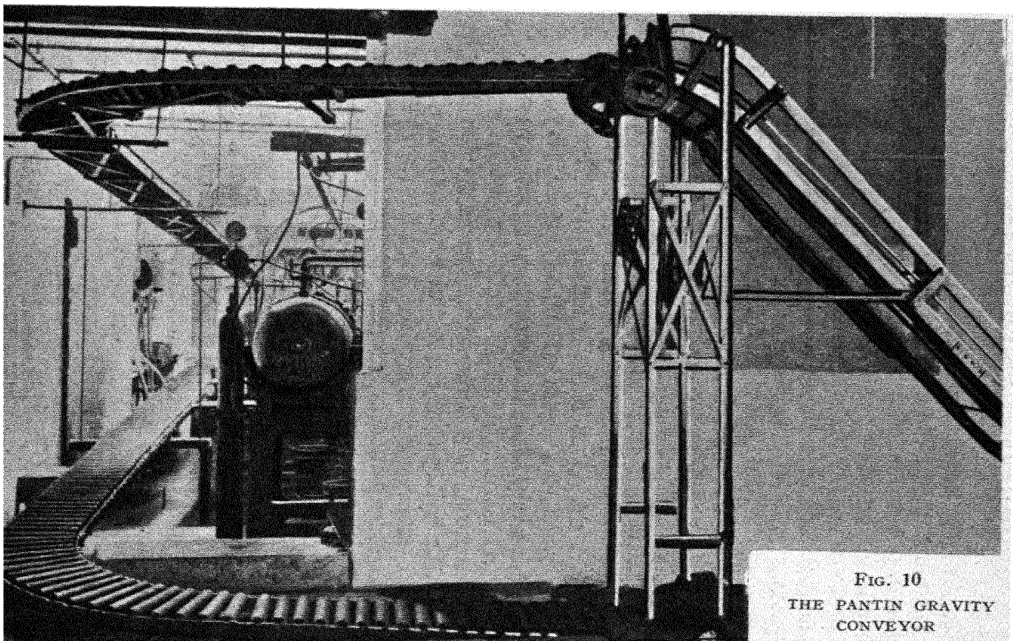

FIG. 10
THE PANTIN GRAVITY CONVEYOR

moves quietly away to its destination without any cost, noise, or trouble of any kind. The cost of operation and maintenance of these conveyors is practically nothing, amounting as it does merely to the wear and tear in the ball bearings, plus the rent and other burden of the floor space occupied. Provided the conveyor track is properly designed and tested at the time of installation, no supervision is required. Automatic charging and discharging mechanisms can be designed and fitted if necessary, and some of these are shown in the illustrations. If the conveyor is a very long one and there is difficulty in obtaining the necessary fall, an elevator can be inserted at any portion of its length, or, alternatively, the grade of the conveyor may be reversed and the rollers compelled to revolve by motive power in much the same way as the feed rolls in a rolling mill are driven to feed the bars into the rolls.

During a recent visit to the United States, I visited a Smallarms Ammunition Factory at Lowell, Mass., that was being equipped, and had partially been equipped, with these conveyors. I was, of course, very greatly struck by the method of transporting material and it was really a fascinating sight to see the material moving about the place quite automatically without any noise, confusion or congestion. One of the things that impressed me most was the striking contrast in point of orderliness between a department in which the ordinary methods of trucking were used and the department doing precisely the same work that had been fitted with Gravity Conveyors. On the one hand, you certainly had a very busy scene but there was a good deal of confusion with piles of boxes, a great many people and a good deal of motion. In the other department, no packages of material were

standing on the floor whatever, no person was present in the department but the machine operatives, and the general air of tidiness and orderliness was remarkable.

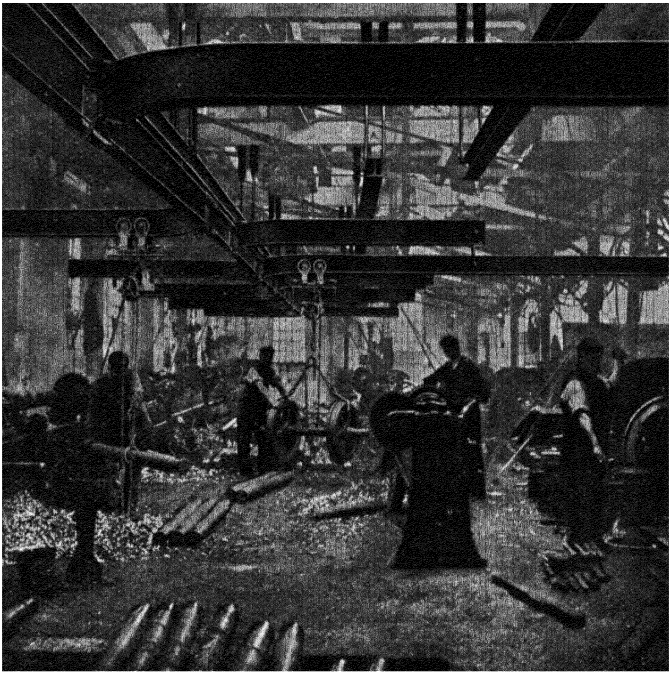

FIG. 11

RUNWAYS, WITH TRAVELLING PULLEY BLOCKS

In my opinion, no one who is laying out a new factory for repetition manufacturing can afford to neglect this method of transport, and those who have existing factories would do well to consider it and perhaps experiment with it.

The illustration on p. 48 shows a gravity conveyor installed by Messrs. W. & C. Pantin and the terminal arrangements often necessary. Both as an eulogium of this method of transport and as an example of a well drafted advertisement, the following is worth quoting—

Greater than Electricity, greater than Radium, greater than T.N.T. The Power that holds and moves greater masses than any other power, so great that it is forgotten, so universal that it is overlooked. It has been working silently, quietly, unostentatiously every second throughout every year that has ever been and it will go on working every second throughout every year that ever will be. It works without cost, without consumption of fuel of any kind and without expert attention. It will be your willing servant and the willing servant of every inhabitant of the earth if need be without in the least detracting from its energy in any other direction. We cannot supply the Power but we can supply the apparatus to let you use the Power. The Power is already in your factory, wherever it is situated, and its name is " Gravity."

Another method of transporting horizontally that is increasingly coming into use in the modern factory is one that requires for its use a lifting appliance and an overhead track—it is the overhead runway. The track may consist of a flat bar set on edge or an angle or a rolled steel joist with its axis vertical, and points, crossings, curves and junctions of all kinds can be provided. The movable piece may be a simple pulley block attached to a trolley running on the track on ball bearings, the whole being moved by manual power, the power required to move a given load being very small indeed; or it may be an elaborately designed electrically propelled mechanism carrying an attendant in a cage. These runways have been developed by a large number of makers. Those illustrated are by Herbert Morris, Ltd.

One accessory to these runways is called a "Transporter Bridge." A bridge, which is exactly similar to the bridge portion of a Travelling Crane

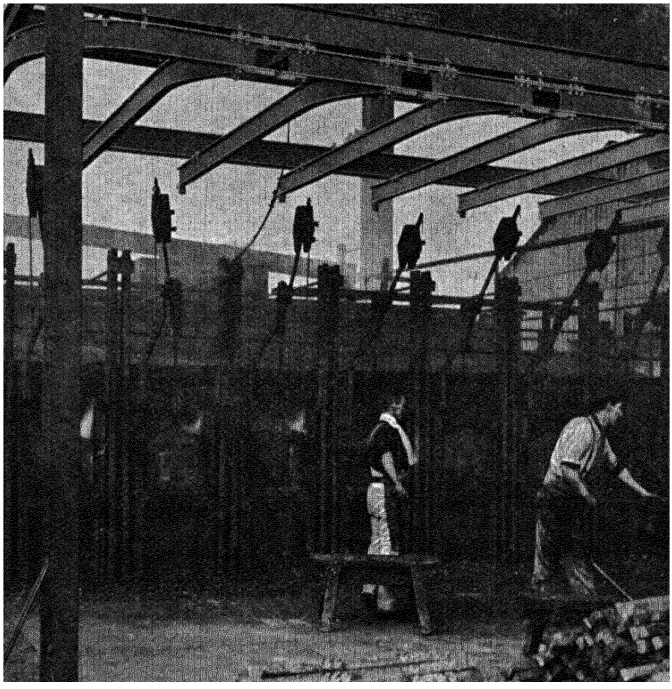

FIG. 12

RUNWAYS FOR CHARGING AND DISCHARGING FURNACES

and has the travelling mechanism but, carrying, instead of a crab a length of runway track, can move at right angles to the path of the runway and thus cross several lines of runways. Stops, more or less automatic in action, are provided so that the bridge

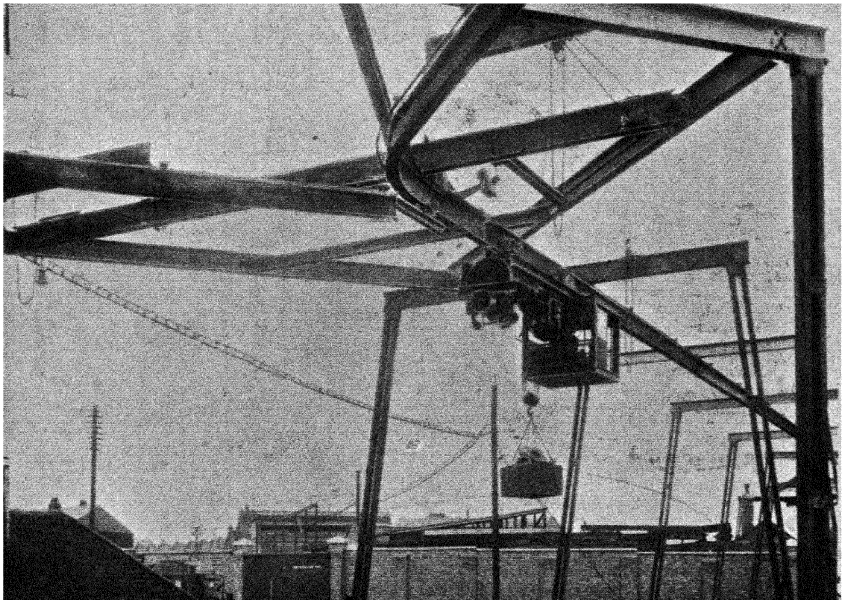

FIG. 13

OVERHEAD RUNWAYS WITH ELECTRIC TRAVELLER, SHOWING JUNCTION

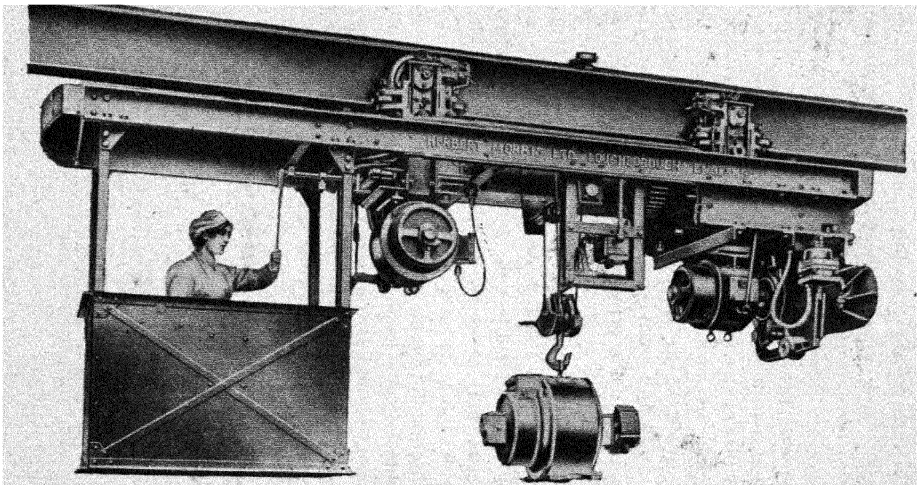

FIG. 14

ELECTRIC TRAVELLER FOR OVERHEAD RUNWAYS

will always stop opposite a line of runway. It is thus possible to run the travelling pulley block or electric traveller on to one of these bridges and transfer it without running round curves or over junctions on to any other line of runway intercepted by the transporter bridge.

There is another overhead means of transport, but it hardly falls within the scope of this article—it is transport by means of "Aerial rope ways" and is generally used for such purposes as conveying ore, fuel, ashes and spoil over fairly considerable distances without any interference in what is going on underneath.

In laying out any new works or re-considering the lay-out of any existing works, means of transport should be carefully considered before lay-outs are prepared, and a review should be made of all conceivable methods and the one best suited to the purpose should be chosen in each case and, as far as possible, single purpose and continuous methods of transport should be preferred to others. The lay-out plans and the designs of the buildings should then be arranged to suit the method selected.

CHAPTER IV

Production

BY H. G. JENKINS

ONE of the most commonly used terms in regard to modern industrial activity is Production, and the looseness with which it is used calls for a definition which will enable us to understand exactly what is meant by this term. One authority defines it as "The producing of articles having an exchangeable value," and, if this definition be accepted, we must be prepared to admit that production includes a relation to market value. So that the object must be to produce within a given cost, which is fixed by the market for which the product is intended.

Now Production in its modern application covers a very wide field, and it is necessary to realize that this field calls for the adoption of various methods to achieve the desired results, and to realize *this* is a matter of the first importance in industrial activity. Modern Production may be divided, roughly, into three classes: Jobbing, General, and Mass; and defined as follows—

JOBBING PRODUCTION is the production of dissimilar items where practically no possibility of repetition work exists, and where, as a consequence, each item of the product must be manufactured individually.

GENERAL PRODUCTION is the production of articles where there is a possibility of repetition work, but where the requirements of an individual article

are not continuous, but offer possibilities of manufacturing by similar methods or processes.

MASS PRODUCTION is the continuous production of similar articles on lines of maximum economy.

Now although distinctions may be drawn as to classes of production, we must realize that there are many aspects of the problem which are common to all classes, and it is these common considerations, which are fundamental, that require close examination and appreciation.

The first—and most important—of these considerations is the necessity to produce at a commercial cost. This necessity calls for the constant observation of the elements of efficiency in all directions; the second is to produce in such a manner as to need a minimum of investment in all producing elements (material, labour, etc., etc.); the third is to produce at a maximum speed possible; and the fourth is to maintain a regular standard of quality. These fundamentals we cannot afford to neglect if manufacture is to be on a satisfactory commercial basis.

Let us next examine the elements of production, and see what are their requisites, taking these in their natural sequence.

MATERIAL. If production is to be carried on economically, we must have a supply of the right material at the right time, and to do this necessitates an efficient analysis of what material is required; and to order it and get it to the producer at the right time calls for a purchasing and storing system which will enable this to be accomplished. We must be in a position to examine this material when received, and to follow it through the various storing and issuing arrangements efficiently. We must also determine what stocks of material shall be carried, that is, what

minimum of such stocks shall be held. All these must have due reference to investment, quality, and speed and difficulty of obtaining delivery.

LABOUR (divided into two parts—Productive and Unproductive) must be planned so that producers of the right kind, skill, etc., are available to meet the production demand. Our planning should ensure flexibility as much as possible, and maintain such productive labour as is essential to the volume of production required. Unproductive labour (*i.e.*, supervision, administration, general services essential to the producing of labour such as inspectors, general labourers, clerks, transport workers, etc.) must also be planned so as to enable the productive labour to be used to its fullest extent on the actual producing, and this unproductive labour, etc., must be maintained in balance with the productive labour under the varying conditions with which we have to contend.

EQUIPMENT. Careful planning is also necessary in order to have tools, machines, and general equipment according to the producing requirements, and all these contributory elements must be maintained in such a state as will enable the most effective use to be made of the material and productive labour, and these must also be maintained in balance. If production at the minimum of cost is to be attained, the planning must effectively ensure that all these elements are kept occupied to the fullest extent possible. Lack of balance in the producing organization means waste and consequent high cost of producing.

TECHNIQUE. We must determine what standard of technique it is intended to adopt and realize that a standard of technique is essential to economical production and especially to the economical use of

productive labour, appreciating fully that careful technical guidance of all productive effort is essential to economical production.

This connection between technique and production needs to be more fully recognized than it is at present. It is no use designing a technically perfect product which cannot be produced on a commercial basis, nor, *vice versa*, any use producing an article technically unsound. This technique must be applied to all phases of production—material, tools, equipment, handling, the product itself, and in all these elements flexibility must be aimed at. We must avoid making cast-iron technique which will mar efficiency, but make provision to enable compensation to be made for variations in the elements which, however carefully the planning is done, are of constant occurrence in the modern industrial undertaking.

Now, in order to appreciate fully what the control of these elements of production really means, we must examine them as problems which vary according to the type of production concerned.

Before passing to these detail considerations, a word of warning may be interposed.

No two types of industrial conditions are alike, and for an English factory to attempt to swallow whole a system in use in an American or any other factory is to court failure, and, however good one system may have proved to be in practice, it is bound to be largely due to the local conditions under which it is used. Beware of importing systems and expecting to work them, without paying due attention to the modelling of the system to the particular local conditions to which it is applied. In no phase of industrial activity does this apply to a greater extent than to that of production.

To return to the detail application of the elements of production to the various classes of production, which have been already defined.

JOBBING PRODUCTION. From this definition it is clear that the problem is to produce an article which has to be treated from an individual standpoint. According to the type of product the plans must be made. These plans must give due consideration to this individuality and cover the elements enumerated in such a manner as to attain the best results.

Starting with the raw material, a strong purchasing department is needed to obtain quickly a large variety of material on meagre information, *i.e.*, without all the paraphernalia of specification, etc. We must buy in reliable markets and be able to obtain quick delivery. In this case it is clear that the getting of the raw material is more important than the price, because material cost is usually relatively small compared with labour cost. Adequate material must be provided and a relatively large proportion of waste accepted as inevitable. In other words, ability to plan the material position is strictly limited and consequently calls for continuous personal effort.

Labour, the next element, will of necessity be of the skilled and highly skilled variety. Labour cost will be high so that instructions may be transmitted to the actual producer without elaborate preparation, reliance being placed on the skill of the producer to a considerable extent. Unproductive labour is a small proportion of the total labour, as there is little preparatory and contributory work possible, and consequently the provision of a small amount of general labour is only required in the department in which the product is manufactured.

Tools are in this instance largely of the standard

type, which can be easily purchased or, if special tools are required, they can be made by the producer, and facilities for the producer to handle his own tool requirements must be provided. The tool problem is not a large one, as a consequence. Machines and equipment need more careful planning. A large variety of machines is necessary to meet large variations in manufacturing operations, and it is necessary to provide such a capacity as will prevent the highly skilled (*i.e.*, costly labour) being idle due to a shortage of machines. So that under these jobbing conditions of production it is impossible to plan in detail the various elements; overall plans can be made, and the supervision (the superintendent and foreman) is expected to control closely the production and must be looked to to plan their production individually.

In this type of production complicated paper systems should be assiduously avoided, and reliance placed on the energies of the individual. If these surmises be correct, then the responsibility of the foreman demands that he shall be given all the essential means to economical production. He must have his cost information at hand, his full knowledge of the requirements and deliveries, etc. To be successful with this class of production, the production control must be entirely local.

GENERAL PRODUCTION. This class of production, which has been defined as the production of articles where there is a possibility of repetition work, but where the requirements of an individual article are not continuous but offer possibilities of manufacturing by similar methods or processes, presents to us a very different problem—perhaps the most difficult of the three classes.

The definition includes quantities of one type of article—collections of quantities of individual items where some features are common, but where the individual type prevents continuous production on a large scale. The problem may, therefore, be stated thus : To plan the production in such a manner as to take every possible advantage of repetition work whilst paying due regard to the avoidance of delay.

Material involves analysis with reference to date of delivery and acquisition by purchase under similar conditions ; the carrying of judicious stocks to meet a wide range of requirements so as to be able to commence production without delay. A strong purchase department is needed, working on a definite system, closely co-operative with the production department, and capable of meeting the demands in an efficient manner. The investment problem in material becomes one of importance. Material requirements must be carefully planned, and co-ordinated over the whole range of the products if economical production is to take place.

The labour problem becomes more involved : what was mainly a highly skilled labour problem becomes a more complicated problem as the field is widened by the use of semi-skilled and unskilled labour possible by the introduction of repetition work. Skilled labour becomes a smaller proportion to the whole labour, and it becomes necessary to introduce inspection as a process in order to ensure the maintenance of standards of technique and quality in the repetition work. Operative and contributory labour introduce a larger proportion of unskilled labour, and considerable economies are possible by the adequate use of this unskilled labour. Considerably more administration is required to deal with the interwoven

requirements of each detail of the product in each particular manufacturing operation, which creates the necessity for detail planning if each part of the product is to be available at the right time for assembling. The problem of maintaining stocks of parts, the balancing of these stocks, planning the production of the parts at the correct rate relative to each other, all require systematic handling. One part may take a month to produce, another an hour, and provision to keep the balance must be made.

We are faced next with a wider tool problem. The manufacture of special tools required for repetition work becomes a matter of great importance, the production of these tools in itself requires detail planning in its own field. Tools which, in jobbing planning, are a matter of cutting only, become in General Production a matter of producing (cutting) and non-producing (jigs, fixtures, etc.), and must be given close attention.

Machines and equipment, by reason of their more selective use, that is, grouping of various classes of machines, are somewhat simplified, but need the constant consideration of balance if the production is not to be slowed up by a want of capacity of any particular type of machine.

Technique enters largely into the General Production problem. The technique and standard of quality now require careful planning: the introduction of detailed instructions, especially to inspection and unskilled labour, are of the utmost importance.

General Production therefore needs sound administration, close regulation, and careful planning of every detail involved. Superintendents or foremen become less directly responsible for the final result of production, and workers are still further removed from

the personal responsibility for the individual article or part they are producing, and consequently provision must be made more closely to regulate the individual operation and effort. The organization needs more development than in the case of Jobbing Production. Purchasing, Storing, Tool Supply, Output Planning, Producing, Inspection, Internal Transport, etc., have all become important problems which must be solved by efficient system.

MASS PRODUCTION. This third class consists of the continuous production of similar articles on lines of maximum economy.

Most of the problems of General Production are present also in Mass Production, but, dealing with larger quantities and continuous demand, helps to a considerable extent the precise planning of production. The term "Mass Production" has been and will continue to be a very much misused term. This class of production is essentially a stable condition of manufacture, the problem being to produce continuously in large enough units each class of product to enable sectionalization of manufacture into self-contained units which will make maximum economy possible. In order to determine the ability to manufacture on Mass Production lines, it is first of all necessary to determine the economical unit of production. That is the minimum amount of each class of plant required to enable the fastest manufacturing operation to be kept in continuous production, and all other operations balanced so as to enable this condition to exist. This reference must be to both machines and labour. Mass Production aims at producing at minimum possible cost, and it is essential to maintain this condition, and if this is to be the case, absolute standardization of the product is an

essential, and this standardization must be both commercial and technical.

Mass Production enables overhead expense to be reduced to a minimum, and this is only the case when producing in such quantities as to enable all factors to be kept in regular balance. The Mass Production unit is complete in itself, and if it is desired to double the production or multiply it to any extent, duplication or regular expansion of the minimum unit will achieve at least this result.

The capacity of the personnel must be carefully measured and kept in balance with all other elements.

To sum up, if it is intended to manufacture on a Mass Production basis, the minimum economical unit of production must first of all be determined, a steady demand for large quantities of each type of product must exist which will enable each item of product to be dealt with in a complete self-contained unit where stability of material supply, design, quality, manufacturing process, and all the contributory elements of production can be assured. Each of these production elements must be carefully studied in detail and provided for by detailed instructions and by detailed system maintained in balance, and be free from external influences. Mass Production cannot be effective unless continuous production is possible under standardized conditions and administered to extreme detail in a completely scientific manner. Then and then only is it possible to obtain the full economic benefits of this class of production, and if these fundamentals are accepted it is obvious that planning all details far in advance becomes the main essential.

Having completed the classification of Production and realized the objects to be obtained, and reviewed

the elements of Production, we must turn to the practical application of the principles enumerated under these heads, which practical application may be called planning.

Planning is the devising of a scheme, and, in relation to Production, involves devising a scheme for the organization of the elements of that production so as to enable the manufacture of the product to take place in an orderly manner and within the shortest space of time possible.

At the beginning it must be realized that it is of no use planning a single element of production: to be effective all elements must be planned if the desired result is to be achieved.

Having enumerated the elements fully in each class of production, a review of the planning of each of these elements can be made. This planning of the elements is applicable to each class of production to a varying degree of intensity—in the case of Jobbing Production to a small degree; in the case of General Production to a larger degree; and in that of Mass Production to an extreme degree. It is not possible in this chapter to do more than indicate the general lines of this planning under each head, and the application must again be made with due regard to local conditions.

In the first place Material must be planned, its quality, its delivery to stock, its inspection, its stocking, its delivery to the producer (worker on machine). Secondly, tools, and tool material: delivery must be planned, the manufacture of the tools, their availability when required for manufacturing the product, their repair, renewal in sufficient capacity to obviate holding big stocks, etc. Next, the Machine itself. Its hourly productive capacity, its rest intervals for repairs,

setting of tools, sharpening of tools, cleaning, etc., must all be carefully realized and taken into account. It is only by planning the machine hours required to manufacture each detail part of the product with due allowance for the incidentals of machine usage that it is possible to make use of the machine to the fullest extent and to balance the various types of machine effectively. Labour—skilled and unskilled—must be planned so as to make the most effective use of it. There is a definite requirement for each class and grade of worker to perform the various processes, and this must be determined by planning labour, realizing that sickness, accidents, irregularity, etc., etc., are all real factors which must be provided for in the plans. Then the actual planning of the work must be by detail process, each process being given adequate consideration, recognition of wastage at each process, and provision of the necessary safeguards for the replacement of defective work. Planning all the subsidiary plant required to deal effectively with the volume of work also needs most careful attention. Labour requires to be planned with regard to the balance of all types—skilled and unskilled; the machine operator and the labourer, the inspector. In every phase must the required volume be forthcoming at the time it is required.

It is therefore essential to realize that planning is not a matter of concern to the department which is responsible for the output only. Planning is necessary, of finance—to be ready to finance the production; of employment—to provide the labour required; of plant—to provide contributory facilities to the production; of inspection—to furnish the necessary methods and standards, etc., by which the quality of the product is to be measured, in sufficient time and

volume to deal effectively with the demand ; storing—to provide the capacity for handling stocks of material and parts during the period of production. Production calls into being all the elements of manufacturing, and must therefore include all these elements in its plans.

The last phase of production with which it is proposed to deal is that of administration.

The necessary co-operation of all elements in production has just been referred to in detail, and in the administration of these there must be definite executive control—control that is effective, that will be sufficient in all directions to prevent waste and delay, that will co-ordinate every phase of production. Supervision must be provided which will ensure responsive effort on the part of the worker, and, by the quick perception of error or lack of essential means of production, contribute to the satisfactory working of the whole.

There must be maintained in each individual a sense of responsibility for his individual contribution to production, and each executive must be kept fully informed as to his effectiveness in carrying out the part for which he is responsible.

Co-operation throughout the whole plant is the final essential to efficient production.

CHAPTER V

Design and Inspection

By R. O. Herford

Specification

It is necessary when producing any article on a commercial basis to have a clear and exact conception of what is required. In some cases the customer tells us what he wants; in others we suggest various alternatives; in either case an agreement is reached and must be embodied in some form of record; a description, a sample, a list of tests, etc. The most usual form for mechanical products is a drawing, either to scale or with dimensions, coupled with a description of the materials to be employed, an exact analysis frequently being stated. This information enables us to reproduce the articles required; and the quantity to be produced governs the amount of detail to be covered. An exact specification is particularly necessary where many workers take part in the production; the requirements have to be split up and stated in such a manner that they have a universal and agreed interpretation. An exact specification to a great extent relieves the individual workman of the necessity of personal knowledge of the product he is engaged on; it enables him to apply his skill and craftsmanship to a great variety of products. Where a product has several components that are finally assembled together, a specification is essential.

Where anything like mass production is attempted, it will be found that the components have to be made at different times, from material obtained from

various sources ; one component may be used in several different products. Unless each part is specified a large amount of selection and fitting will be required at final assembly ; this increases the costs and the finished product does not agree with the sample. Part of it may have to be sold at a lower price on this account, even though the cost is as great as, if not greater than, the cost of the sample. Therefore what is being made must be known and recorded, otherwise the quality of the product cannot be guaranteed, nor can we be sure that it can be profitably produced at the price agreed upon.

A specification must be relative to a standard or set of standards. Mechanical products are described by their dimensions in feet or inches and the strength and analysis of their materials. Textiles are governed by their weight and fineness of count. Rubber and similar products by the specific gravity and resistance to mechanical and chemical tests. In every case some agreed standard must be available and convenient, if accuracy is to be maintained. If standards are referred to, accurate methods of comparison or measurement must be available. It is no use trying to measure to a thousandth of an inch with a two-foot rule ; nor is it any use specifying a heat treatment to 5°C. if our pyrometers will not read nearer than 10° either way. In using a pyrometer, allowance must be made for the width of the needle point, and of the lines on the dial ; the sensitiveness of the mechanism ; the effect of surrounding conditions on the electrical factors, the method of applying the pyrometer to the work or the furnace. When measuring an object we must examine the state of the surfaces ; must know its temperature ; and must allow for the sensitiveness of our measuring instrument and our own

skill in using it. These considerations indicate that exact measurements cannot be effected. The causes of variation may be reduced to infinitesimal proportions, but are still present. The Standard English yard is housed at the National Physical Laboratory, Teddington; it is made of Invar steel, is mounted in a special building on a solid foundation. The temperature in this building is constant and the scale is only viewed by artificial light of known intensity. In making a specification, therefore, we must allow for variations due to the methods of measurement or comparison.

When methods of production are considered, still greater allowances have to be made. Any tools begin to wear as soon as they are applied. At each application they produce a slightly different effect. The material they work on is not really uniform; they are applied by different persons on different machines. The degree of accuracy obtainable depends on the refinement of the instruments used and the skill of the worker, whose control depends upon his knowledge of the process.

The allowance that must be made for variations in measurement and production is known as "Tolerance," the extremes permitted are known as "Limits." A specification must state not only the dimensions, etc., but also the tolerance allowed; otherwise the product, which may have been considered "near enough" at the time of manufacture, will be found to vary more than was anticipated, particularly if the variations occur in such a way as to be added to each other. To determine the tolerances, therefore, is a most important part of making a specification; it calls for experience and judgment, and no expense should be spared in this direction; if crude or impossible tolerances are stated, the result

is worse than where none is given, and custom and tradition relied on.

Operation Lay-Out

Having a clear conception of the product, we must next decide how it is to be made. There are always various methods to choose from; each may have some good feature. Various methods may be tried successively or at the same time; in any case the results should be carefully recorded. This enables us to apply our experience to various jobs in which the same elements occur, and is the simplest form of research. Each method should be analysed and all the conditions noted at the time they occur; at a later date the good features of each method can be combined, and the one best way for your factory laid down. This is, indeed, the most expensive form of research; if the investment can be afforded, it is much cheaper to make experiments independent of production; and begin production only when the one best way has been found. In any case, the operation lay-out must be based on definite data, and not on guesswork if it is intended to produce a given article; and by accumulating information in this way, it is possible to forecast with considerable accuracy the method most suitable to a particular works, before an ounce of material has been cut up.

The equipment employed should be suitable for the work in hand. If the work is in small quantities and of a variable character, universal machines and simple tools that can be readily adjusted are required. If the work is standardized and in large quantities, special machines and costly tools will produce it faster and cheaper than any universal machine can ever do; and will not require as much skilled attention while

running. Special equipment must be designed for its own purpose; it cannot be bought in the market. It should be conceived by an expert who must be informed of the exact requirements of the job, and the performance expected. As a general rule the machine should be strong enough to break the tools without injury to itself; if you succeed in producing a tool it cannot break, you need a new machine, or you are not getting the utmost from the tool. Durability is another vital factor in special machines; if they break down, the work must be held up or completed on another machine which is necessarily less efficient. In designing such machines, the position of the operator must be studied; the controls must be so placed as to call for a minimum of effort on his part. This depends on the motions he has to perform and the force he has to apply; and the levers should be so arranged that personal injury is impossible. Special machines, therefore, must be strong, durable, suitably proportioned to the work; they reduce fatigue, and prevent accident, and will work at a higher absolute efficiency than any universal machine.

Whatever machines are employed, or even if all work is done by hand, the tools used must be efficient. The conditions of efficiency in a tool are—

(*a*) Reasonable life.

(*b*) Convenience when changing or re-setting.

(*c*) Performance, *i.e.*, amount of work produced relative to cost of tool.

(*d*) Exact reproduction, *i.e.*, each tool must be the same as the last.

These conditions will be found to apply to all tools, whether for lathe or hammer, forge or rolling mill; to files, form tools, grinding wheels, marking stamps, spades, or watchmakers' tweezers. One of the most

perfect hand tools existing is the tailors' scissors; the handles are beautifully moulded so as to avoid fatigue, and guide the hand to the best position; it is well balanced, makes a clean cut, and the tension between the knives is regulated. How many of the tools we are accustomed to are as efficient as this? The tool designer must know the properties of the various tool steels available, and the effect of heat treatment; how much work may be expected before repair is required; how the tools will be made and how exact they will be. He will have to divide the tolerance allowed into three unequal parts; the largest part for the worker who uses the tool, the next largest for the tool maker, and the smallest part for the gauge maker. Each of these men demands some tolerance—he cannot work to absolute accuracy. Indeed, a fourth allowance is required, namely—for wear of the gauge before it must be considered useless. It is possible and practicable to divide up a total tolerance of ·002 inches into these four portions; but to do this demands knowledge and experience, and cannot be undertaken lightly. Finally, when laying out operations, certain factors that are non-technical in character must not be neglected. The equipment should be balanced—that is, we must not find ourselves short of one kind of machine, and with too many of another. Hence the general efficiency of various classes of machine must be known, and allowance made for the idle time, operator's efficiency, and conditions under which the plant will run. If the raw material is costly, the management will keep the amount in progress at a minimum; rapid production at short notice is required, and a few extra machines will be required; if the material is cheap, a large stock will be carried and steady runs may be expected.

This kind of allowance varies greatly with different classes of equipment ; and may upset the calculations of the purely technical man to a surprising degree.

To sum up, our existing operations should be studied and future ones planned. We must use data derived from experience ; must provide suitable equipment and arrange for adequate tolerances at each stage ; and must keep ever before our minds that the object of this technical planning and research is to obtain better or cheaper work, and not to create ingenious and intricate methods. Technical planning is as essential as financial or production planning ; by its means alone can mass production be successfully achieved.

Technics

How are we to arrange for this technical planning ? Who will lay down the most economical way in which to produce our varied products ? Shall we not educate our workmen well and rely on each one to develop the way that suits him personally ? By all means ; but it will even then be found that the men are not all alike. One man will be found who is always thinking of ingenious little fixings and devices, and is usually behind with several jobs ; another will use a few simple tools beautifully finished and cared for ; a third will produce good work and no scrap ; a fourth a large output of passable work. Look out for the inventive man. Take him off production where he is worried and ineffective ; give him a quiet room and a lathe and let him invent things for you. When you have two or three such men around it is wonderful what results can be achieved, especially when each of them makes one branch of the business a special study. When any difficulty arises in any branch the

expert is referred to for help; if he is a real expert he will be asked readily and freely, and will be glad to help. If possible, appoint a secretary for your experts, or a manager who will record their observations in a convenient form for their future guidance—they are frequently unsystematic.

If their work is to be successfully applied, all projects of a major character must be discussed at conferences attended by representatives of the manufacturing, toolmaking, and inspecting departments. These men will examine the proposals not only from their own professional point of view, but also from the personal side, and will make suggestions and criticisms of value. Furthermore, they will regard the project with sympathy rather than hostility when it is put into operation; in any case they will have to do the work and see it through to success, and should, therefore, be prepared as long beforehand as possible.

Before the plans are completed, experimental models should be made to test any point of doubt, however trivial; it will have to be tried some day—better now than when the salesman is demanding output. Some of the wealthy American corporations carry this to its furthest limits. Their laboratories include a manufacturing department, and commercial production is not started until every tool and gauge has been proved under manufacturing conditions, and the tool-making problems solved. This is ideal economy; but much may be achieved by experiments of a simpler nature.

The work of the technical expert is not complete when his plans have been agreed to in conference, and proved by experiment. He must be ready at the appointed time to demonstrate the methods and prove the tools. He must be able to impart his

knowledge, or he must have someone who can do this for him, to the worker who has to manipulate the tools provided. If the expert cannot demonstrate that his method is the best in practice, you cannot expect the worker to believe that it is. Furthermore, demonstration keeps your expert in touch with shop conditions and introduces him to the ordinary difficulties that are easy to overlook; their solution will be embodied in his next design.

Technical experts must keep abreast of current developments in their own branch and also in other branches more or less allied. This may be done by studying technical periodicals and by exchanging visits at other factories in other districts. Much may be gained by applying the methods of one industry to another; technical research and experiment, if conducted intensively in one factory, only tends to over-refinement and unnecessary complication. Mechanical processes can be seen in their true perspective in a watch factory and a textile machine shop; in an electrical instrument factory and the village smithy. On the one hand we can observe the present limit of human ingenuity and applied research; on the other the possibilities of manual skill and simple tools. I suggest that our technical institutions should seriously arrange for the study of comparative technology; such a course would include a review of the textile, mining, chemical, engineering, and electrical industries. Attention would be paid to the process rather than the product, and details would have to be avoided owing to the magnitude of the work. But details can always be obtained from specialist books of reference on almost any subject; indeed, our trouble is that we are at present faced with such a mass of information, that it is hard to know

where to look for help when difficulties confront us. When we see a loom in operation we marvel at the number of threads, and the speed and precision of the shuttle. A weaver admires the stout and highly finished machines in an engineering works, performing what he considers miracles upon hard and obdurate material. The perspective obtained by comparisons of this kind is of immense value, and would help us towards clear thinking and the accurate solution of our own problems.

Inspection

Inspection is a branch of Industrial Administration that has gathered much controversy round it ; and it is frequently the occasion of continuous guerilla warfare in factories of varied type. No attempt will here be made to describe the various ways in which inspection may be applied or organized ; my remarks will be confined to the need of inspection and the value of its work. Its application is a problem for the individual factory ; and will depend on the class of work, the type of other organization, and the general relations of the personnel.

Inspection is necessary to ensure that the goods supplied to the customer are in accordance with his requirements. In some cases, human lives may depend on the quality of our product ; it is difficult to be sure that they do not. Ordinary commercial morality should compel us to ascertain that defective or inferior goods are not being supplied. Our salesmen can secure orders with greater ease and confidence if they are able to give their customers a guaranteed quality without reservations of any kind. For it must be recognized that no organization is infallible and some mistakes are bound to occur. It is surely

better to find them ourselves than have them pointed out by our customers.

Apart from mistakes, it will be found that slight variations are inevitable. An inspection department detects them, and if they are of a trivial nature, either passes them or notifies the salesman, who can then give his customer the opportunity of rejecting the goods if not suitable. Inspection is an essential feature of mass production. It is pointed out at an earlier stage that components have to be made at different times and assembled at some future date. Hence each component must be examined on completion before going into stock ; otherwise trouble is bound to arise at assembly. Not only must components be examined when finished, they must be dealt with at intermediate stages as well. If this is omitted, expensive finishing operations may be performed on work already faulty ; the tools and methods employed may not be able to deal with work outside the limits ; they may even be destroyed by it. For these reasons alone, continuous inspection at suitable stages is of paramount importance ; it eliminates the cumulative effect of normal accidents.

It will be found that other advantages are obtained. If the equipment produced good work yesterday, and bad work to-day, some condition must have changed ; and the sooner the source of error is discovered the better for all concerned. Frequently it is necessary to inspect and gauge the work as it comes off the machine ; when it fails inspection, the machine is stopped and the tools adjusted and repaired, thus saving time and material.

When faulty work has been produced, the inspection system sorts it out and states the fault. It can be

put on one side and rectified as opportunity arises. Thus serviceable material is saved and no work need be scrapped except with the sanction of a responsible and competent man.

The inspection system must be closely related to the department purchasing raw material, so that they are informed of all trouble arising from that prolific source. All material should be inspected before acceptance; this enables the purchasing agent to communicate immediately with the supplier. The complaints received from customers and salesmen must be thoroughly examined and their origin reported on. As a final justification of elaborate inspection, stocks may be correctly valued. It is not a simple matter even to count stock; it is still more difficult to say whether it is really all of full value. When the material has been inspected before acceptance—the product before going into stock; the defective work in need of rectification put into a separate store—then only can it be said that the stock values are even approximately correct.

The inspection department maintains a consistent accuracy and finish throughout the works. They hold the standards to which all comparisons are made. These standards may be general to the trade or special to a particular works; in either case they will call for skill and experience in their application.

And, finally, the responsibility for bad work does not lie with the inspector, but with the producer. No inspector can make bad work; he can only discover it and point it out. It is his aim to help the producing departments in every possible way; but he has to take responsibility for the goods supplied to customer. On this depends the goodwill of the firm, and to a great extent its prospects of future orders.

CHAPTER VI

Personnel.

By R. O. Herford

In this chapter it is intended to offer some general observations on the human factors of Industrial Administration. The human factors are the most difficult of all the elements to deal with, because of the infinite variety of the human mind and temperament ; and the most vital, because no material factors, such as buildings and machines, can be made use of for production, however wonderfully conceived they may be, without the direction and manipulation of the human brain and hand. In addition to this, manual workers in all industries are making serious demands and assertions, and are possessed by a firm determination to improve their general conditions of employment, to an extent that would have been impracticable twenty years ago. These assertions and criticisms are voiced by men of education and intellect ; they have to be met by reasons and arguments of equal soundness ; and the balance of power to dispense with argument has passed from the employer to the workman. It is no longer feasible for the director or manager to make arbitrary decisions and enforce them ; he must be prepared to justify every action he takes, if not to his individual employees, at any rate to his fellow employers and the general public. Hence he must act with caution and foresight, and must follow some plan or scheme of things if he is to preserve consistency, and be able to deal with his daily problems in such a way as to avoid inharmony

among his staff. This leads to deliberate rather than quick decisions; and experiments in human relationship cannot be made in the haphazard way that was possible only a few years ago.

In the midst of these difficulties we are faced with the problem of reconstruction. Not only were our methods and equipment entirely rearranged by the war, but our human industrial units were broken up and re-grouped: men we had been working with for years disappeared in a night—many of them never to return; and their places were more or less filled by strangers with whom we were unacquainted. These in turn have vanished; and the original members of the staff have to pick up the threads again under conditions very different from those obtaining when they went away.

We are urged to produce more; to bring ourselves up to date; to reorganize our business. American and German achievements are referred to, and we are begged to learn from them. Let us do so by all means, but not without a vision of the goal we are aiming at; nothing can be gained by blindly following methods that we do not understand; particularly will trouble arise, if we act blindly in our human relationships: I propose to indicate considerations which, even if they do not compel agreement, can at any rate be clearly stated and may provide a stimulus for individual thought.

Organization

Organization is not a matter of systems and routines. These are often confused with organization, but are merely the tools it uses, and the maps it follows. The work of ten men is ten times that of one man only when their efforts are so arranged that they are

in the same direction, and do not oppose each other. If five pull in one direction and five back, less result is obtained than if one man only was pulling. Hence, organization is not a matter of numbers but of co-operative action on the part of a number of individuals; and the first essential of co-operative action is a common object or purpose. The common purpose must form a part of the purpose of each individual; it will be combined with other purposes according to individual characters and conditions. The common purpose should be expressed by the active head of the business; all his actions should be in that direction; he must have a clear idea of what it really is, and must see that all persons below him have grasped it and are working towards it. If you are attracted by a certain line of business, and wish to earn your living in that line, then do so. If you want to make as much money as you can in the shortest time, be candid about it and clear out when your object is achieved. We have probably several purposes before us, major and minor, ideal and essential; we must be clear as to their classification, and not allow minor purposes to impede major ones.

If co-operation is to be successful, then the duties of each individual must be clearly conceived and recognized; otherwise overlapping and confusion will occur—conditions which foster jealousy and narrow-mindedness. Each member of the team must know his appointed place; from whom to expect his work, and where to send it. Unless he knows how far to go, sometimes he will not go far enough, *i.e.*, leave work undone; and sometimes will go too far, *i.e.*, do someone else's job. He should also be acquainted with the course of things for some distance before his duties begin and after they end, so that

he can act with intelligence and confidence when emergencies arise. Only when each man's duties are clearly defined and understood can he concentrate his attention and work with speed and confidence. We must therefore carefully divide the work to be done among the staff available, and see that each member knows his own scope and duties and is acquainted with those of the other members.

Accurate subdivision of this kind has probably been further developed among the manual workers than among the controlling elements of the staff at the present day, though it is of equal importance at each stage. We find that the actual work of production is handled by the following groups of workers—

Operators, to manipulate the machines.
Charge hands, to give technical assistance.
Inspectors, to view the work.
Labourers, to move and lift.
Foremen, to supervise and overcome difficulties.

But among the controlling workers the subdivision is much less exact, largely owing to the fact that there is no visible product of their work, and to the somewhat hazy notions of what is expected of them, both as regards the field they cover and regarding their responsibilities. It is a good plan to draw up and display an organization chart showing the various offices and the names of the persons who hold them. It is surprising how many questions will arise and will have to be answered before this can be done; these questions represent doubts and uncertainties that actually exist, even when they have never been expressed; but the sooner they are dissolved, the better for your organization.

The subdivision of duties involves the delegation of

authority and responsibility; this must be clearly recognized. If you unload some of your own work on to an assistant, you must let him carry it as much as possible in his own way, which is probably different from your own, and possibly quite as good. If his work is unsatisfactory, don't get into the habit of reversing his decisions, but find someone whom you can support in that post. It may take weeks and months of training and mutual experience; but in the end you are no better off unless he can make decisions for you. If your assistants are glorified secretaries, all decisions have to be postponed if you are away from business; on your return, arrears of work are waiting for you and time has been lost. Where your assistants have each got a staff of his own, their work should be similarly divided; some responsibility must be given to each man.

If you find yourself overworked, and decide to have an assistant, don't ask him to handle the whole of your job; if he has to cover as wide a field as you do, he will be equally overworked and short of time, unless his capacity is greater than yours. Give him a part of your work; he will then have time to concentrate and develop details which at present have to be ignored or rushed.

You can pass on to him all questions that come within his sphere and can concentrate your own energies on the rest of the job. If you frequently reverse his decisions or keep the decisions in your own hands, people will not consult him, and your time will be as full as ever it was.

It may be stated as a fundamental principle of organization that where duties are delegated the sphere of each delegate should be less than that of the superior. If a man has two assistants, he should

divide three-quarters of the work to be done between them; he will then have time to do the remaining quarter himself, and supervise and control his assistants. This gives him an opportunity of training his assistants, who are able to attend to details for which he has not time; and will give each of them a thorough grasp of one portion of the duties so that they are fitted for promotion when the opportunity occurs.

Arrangements should be made that when any person in a controlling position is absent through sickness or other causes, a substitute should be immediately obtainable. This is usually managed by giving temporary authority to one of the absent person's assistants. This is an excellent plan, as it gives him an opportunity of showing his capacity in a larger sphere, and of learning the kind of problem he would be faced with if he held the higher position. Another plan that has much to recommend it is for the absentee's superior to step down and carry on for a bit. This will refresh his experience of the more detailed work, and will bring him in contact with a different staff. Whichever way may prove the more convenient, it is important that the absence of one individual should not disarrange the work of a number.

To summarize these points, in a well-organized staff the duties are divided among its members; the division must be recognized and understood, and responsibility given. The duties of each man must lie within a narrower field than that of his superior, and every key position must be safeguarded by a possible substitute.

Classification and Selection

In attempting to subdivide work the question arises: How are we to determine the various posts

that have to be filled, and how shall we find the men to fill them? I suggest that all work, other than manual, may be classified under four headings—

1. Executive.
2. Technical.
3. Recording.
4. Commercial.

These are particularly convenient, because human characteristics may be grouped in the same way; and therefore men can be found particularly suitable for each post.

Executive work consists in getting things done; in taking action, and making decisions. Difficulties have to be recognized as they occur, and not merely regarded as the working of Providence. It involves the control of other people and the arrangement of their work so that they all pull together, are not overloaded, and are satisfied. Many different kinds of job have to be kept in sight at once and in their true perspective. Particularly must executive work embody the main purpose of the business, if delay and confusion are to be avoided. In a shoe factory, every executive must be possessed of the idea that shoes are the main thing, and must take advantage of anything that will help in the production of shoes. He will be indifferent as to who designs them, and who invents the machines for making them, so long as they do not impede him in the production of shoes. In short, an executive is a man who issues instructions, and sees that instructions are carried out.

What are the characteristics of a man who can undertake executive duties? First, he must have character and personal force, so that he can speak with authority, and not as a clerk; he must gain the confidence of those under him and those above him, as a man who knows where he is going, and who intends to get there. He will have energy, patience,

tenacity; will know his own mind and not be the victim of irresolution. Imagination and intuition will enable him to modify surrounding conditions and circumstances to suit the end in view; foresight will find him prepared for troubles as they arise. He does not require deep technical knowledge, nor does he need great powers of concentration; rather must he be alert and ready to turn from one problem to another, with untroubled mind; and judge each question on its merits, unprejudiced by previous worries.

Technical work is very different; knowledge and practical experience are the important qualifications; the technical man answers the questions and solves the problems indicated by the executive. He must be able to concentrate and to become absorbed in a particular subject, and must be so placed that his attention is not distracted by external day to day worries. The technical man requires liberty and tolerance; he must follow his own train of thought and should not be restricted in his experiments. Some find it congenial to work on two or three problems at once—others to complete one idea, have a rest, and proceed to another. Admirable technical work can be performed by men who are quite incapable of executive work; their inventive ability is akin to that of the artist, and they must be treated with due consideration. Their work must frequently be organized for them, so that valuable ideas may take a practical shape, even at a date much later than the original conception. Nothing is so disheartening to the technical man as the time that must elapse before his ideas are embodied in regular practice; but he should not be allowed to disturb production by untimely experiments.

Records are necessary in every branch of the business, if we are to preserve the result of experience.

Executive men have no time to keep records, and little taste for it; their mind is on the future; technical men desire records but are also absorbed in their own work and ideas. For record work a man should be found who delights in accuracy for its own sake, and who has imagination to realize the kind of information that will be required, even though he has neither the ability nor opportunity of using it himself. He has to select the information to be recorded, and to reject the irrelevant; he should make a study of clerical systems, so that information may be circulated with a minimum of time and labour. Recording work is often undervalued and regarded as a minor task; it is really important, and demands ability, imagination, and persistence.

Commercial work is that covering our relations with other firms, that is, buying and selling. In selling, we require personality, character, and enthusiasm. The selling man must be able to get into friendly touch with a large number of comparative strangers. He must uphold the traditions of his firm in the outside world, and must take pains to discover his customers' real requirements. He should also appreciate manufacturing difficulties so that he can convince his customers that their interests are receiving attention.

The buyer requires a wide knowledge of goods and prices, and a keen appreciation of value. He controls the second largest item, in some cases the largest item, of the firm's expense. He must possess character, energy, and knowledge; and also be able to meet the outside world on terms of equality.

I have already mentioned that manual work is considerably specialized and subdivided; it will be found that the same classification may be applied

to it as to control; thus the foremen should be executives and the charge hands technical men; where possible the charge hands should be trained in executive work so that they are ready for promotion. A somewhat different class may also be recognized, and that is the craftsman. He delights in a good job for its own sake; he desires a variety of work to enlarge his experience and exercise his skill, and is best pleased when confronted with a difficult and accurate class of work. Great attention should be paid to the training of craftsmen, and foremen should be drawn from them wherever capacity is shown. By this means you secure a high standard of workmanship and productive efficiency among the operators; the scrap factor is reduced and the methods and tools laid down by the technical staff receive adequate trial and proper use. Developments in mechanical processes are largely dependent on the skill of the craftsman; but it should also be recognized that productive efficiency does not appeal to him, as it does to the operator. Operators are ready to follow instructions and are not fastidious as to the particular job, so long as it is remunerative. They can be readily trained on specialized or restricted jobs of a repetition character; their idea of a good job is something that will pass the inspector; output is their principal object. This is a desirable quality in itself; but do not expect an operator to do a craftsman's job, until you have split up and standardized the work required.

Co-ordination

If we accept this analysis of work and men, we have still to choose our men, to weld them into a unit, and to stimulate their enthusiasm.

The selection should be guided, if not controlled,

by an Employment Manager. He must possess judgment, sympathy, and firmness, and must be himself of the highest personal character, if the staff are expected to trust him. He has to attract the desired kind of help to the business at the time it is needed; he must be acquainted with the feeling in all ranks, so that grievances are appreciated and dealt with as quickly and quietly as possible, and not allowed to grow and rankle. He must prevent the young people from entering blind alleys, and must find comfortable and suitable jobs for the older ones. He should have an idea of the latent abilities of the staff so that when opportunities arise, these may be developed, rather than new men introduced. He will supervise the training of apprentices, and the general amenities, deal with accidents and the factory inspector; handle benevolent funds and insurance. He is, in short, a specialist in the human problem, and this is with us whatever our business may be.

I have already defined organization as being the co-operation of individuals with a common object; we have still to see how the different types of work and men are to be associated so that this may be achieved. Generally speaking, any group of workers should be controlled by an executive. In some cases a technical head with an executive assistant will be found convenient, but usually the opposite is preferable, because one executive can guide the work of several technical assistants. Furthermore, the line of authority is found to be shortest where the executive duties are concentrated. The workman reports to the foreman; the foreman to the superintendent; he to the manager, and the manager to the directors. It may be found desirable to employ a large staff of functional assistants to deal with

planning, tool design, inspection, etc., but these men should not interfere with the line of authority, which must be the only channel of reward and reprimand. The responsibility for making use of the information supplied by the technical functions lies with the executives and not with the function ; on the other hand, the technical functions must be supported and made use of, otherwise they are a waste of money ; they will feel disappointed and will lose interest in their work. The organization suggested for a factory therefore consists of a manager who has a staff of technical assistants. The result of their work in the form of plans, drawings, tools, etc., is communicated by them to the foreman direct. The manager, however, must delegate his authority to a few superintendents who will see that the plans are followed, and the tools made use of by the foremen ; they will also check overlapping and extravagance ; and will note and report problems as they arise, and will develop temporary expedients. Regular conferences between the manager, technical assistants, and superintendents should be held, where progress is reported, and proposals examined before decisions are arrived at. Such conferences are of great value ; they must, however, be under the guidance of a chairman, who has power to make decisions and see that these are carried out ; otherwise they are a waste of time. The superintendents also transmit to the foreman and the workman the general policy adopted from time to time, and generally keep affairs of all kinds in harmony. This kind of work has become particularly necessary in recent years owing to the advent of an entirely new factor in industry, namely, the Shop Steward Movement. Space will not permit me to enlarge on the various aspects of this factor ; but

something must be said because it cannot be ignored and because it vitally affects the position of the foreman. Regular meetings should be held by the manager with the shop stewards, who should be asked to state beforehand items they wish to discuss. It will be found that, when the stewards have regular access to the manager, they will themselves investigate grievances pretty thoroughly before bringing them up, and in that way will deal with a lot of minor worries. The management must support the foremen in the actions they take; and the foremen must realize that they will be supported, and therefore must not act in any way that will put the management into an impossible position. Hence the need for close personal touch and mutual understanding between all sections of the management.

Stimulation

Having perfected the plans for our organization, and filled every post with a competent and suitable man, we have still to set things in motion, and keep them moving. No machine has yet been invented that will run of its own accord; invisible energy must be supplied by some means merely to keep it moving, and a considerable amount is necessary to start or accelerate it. This is equally true of an organization, but with this difference; that whereas a machine is so constructed that it functions correctly when energy is supplied at one or two points, yet we find that each member of an organization must be energized if the desired cumulative result is to be obtained. If one or two members hold back or work sluggishly, the efforts of the others are to that extent discounted; and the stimulus required will vary in kind and degree according to the character of each

individual. The main purpose of the business is only a part of the general purpose of each member; and unless his general purpose is being attained the individual will be dissatisfied. It is a mistake to suppose that the matter begins and ends with remuneration; in many cases other factors are of equal or greater importance. An energetic and ambitious man desires scope; he will not do routine work for any length of time, whatever he is paid. A diffident and retiring man will shrink from responsibility; a young man desires prospects, and an older man a safe post. The craftsman will not undertake repetition work, nor will the productive worker waste his time polishing gauges to fractions of one-thousandths of an inch. Each of these men must be able to maintain his own standard of living, but if he is to put forth his maximum effort, his work must be congenial, and he must feel that it is of value in the general scheme.

In the first place, therefore, each man's remuneration must be adequate, and as liberal as the business will allow; if he feels that he is not getting his share of the proceeds, he will grudge his best effort. Secondly, his efforts may be rewarded by some system of payment by results, so that the harder he works the more he is paid. This idea found great favour during the war, and is regarded by many people as the ultimate panacea for all our industrial troubles; personally, I do not believe that the results expected will be achieved, because for every man satisfied you will find another dissatisfied. If your workers are convinced that they are getting a reasonable share of the proceeds, they will not worry very much how their wages are made up; if they are not convinced, then every complication is a source of suspicion. Another variety of this plan is to pay a high day wage

for the performance of a certain task, which is set so high that it calls for maximum effort ; those workers being discarded who cannot achieve it. This is probably preferable to payment by results, but it implies a high degree of standardization. Personally, I believe that day wages are preferable where both work and conditions are standard ; and payment by results where conditions are standard but the work varies within relatively short periods. Where the work is standard and continuous, small variations in the conditions will cause larger variations in the output ; these have to be allowed for, if a man's earnings are low ; or else give him an advantage over his fellows out of proportion to his efforts.

What is known as Welfare Work is also regarded as valuable. It is so in so far as it represents a genuine desire for decent and humane conditions ; but I feel that an eminent American manufacturer whom I met was too sanguine in thinking that the beautiful lavatories and cloakrooms in his factory would prove a bulwark against Bolshevism and discontent. Spiritual and moral troubles must be met by remedies of the same character ; material conditions can do no more than prepare the way. It is indeed good to note that in many industries the general welfare of the employees while in the factory is regarded as a duty and a necessary charge on each firm. This feeling extends not only to their general physical well-being but to their education ; it is to be hoped that carefully prepared and systematic schemes of apprenticeship will be revived before long.

One valuable form of stimulus is the recognition of merit followed by promotion. Your whole staff is dismayed and disappointed when an outsider is engaged for a good post, which they feel could have

been adequately filled by some member of the existing organization. The ambitious men soon begin to look outside for their advancement, and the grumblers have something to grumble about. If at all possible, new blood should be introduced at the bottom, not at the top, and every man should feel that some opportunity is open to him, and that the efforts he is making are being noted. Above all, trust your staff; if a man is untrustworthy, get rid of him—it is quite likely that in other surroundings he will prove satisfactory. An honest man is hurt and alarmed if not trusted; even a dishonest man hesitates as a rule before breaking faith.

But the final and real stimulus is the hardest to achieve; it produces the most valuable and permanent results, and is the basis of all other stimulants. I refer to personal contact and example. A leader only leads by virtue of his power to influence others. If he is lazy, his men will not be energetic; if slovenly, they will not be tidy; if he wastes time on non-essentials, even though he appears to be full of work, his men will not efficiently regulate their own activities. If the leader does not know his men, they will not know him and will look on him as a stranger. Spasms of generosity are no substitute for justice, and favouritism destroys all faith in your leader's fairness. The basis of example is self-discipline; the slightest actions of a foreman or manager are noted and commented on, very frequently quite unconsciously, by the men who surround him. They observe him from different points of view, and he has not time nor should he be required to give reasons for every action. Nevertheless, his men will attach more importance to his actions than his words; rapid decisions are required, and self-discipline must be continuous if he is to act

freely and naturally, and yet not fail under the gaze of those around him. Where the leader himself obeys the instructions he gives to others, and conforms to the principles he has enjoined on them, he may confidently demand the same effort from his subordinates that he puts forth.

If we are to place our industries on a sound permanent basis, we must convince all taking part in the industry that they are not being exploited; that ability is recognized and offered an ever-widening field; and that the work of every man is necessary and to be respected, however humble his duties may be. Then only may we look forward to a period of comfort and contentment in some degree worthy of our desires.

CHAPTER VII

Sales Management

By H. T. Hildage

Duties and Relationships

The primary and most obvious function of a selling department is to sell the product of the concern either at the best price the market will allow or at a profit over manufacturing costs that will show a reasonable return on the capital invested. Antecedent to this, however, whilst the business is in process of conception, the selling department will have been advising the directors as to the probable extent of the market available, as to the qualities that the goods must have in order to fill the requirements of that market, and as to the price that can be obtained. It is obviously no use beginning to manufacture an article that you know will cost at least £10 to produce, if you also know that in all human probability you could never get more than £8 or £10 for it ; nor is it any use putting down plant to manufacture a million per annum of a particular article if the present consumption of that article is only 800,000, unless by producing something cheaper than has been produced before and of the same quality, or something of better quality, at the same or a lower price, you are absolutely convinced that the demand can be increased from 800,000 to 1,800,000, because, of course, it must be remembered that the people who are manufacturing that article to-day will not cease to do so simply because you have established a factory for the same purpose. If the total demand remains the same, it means that you will only get a share of it, and that

share will depend on the relative quality and price of your products and those of your competitors; but don't lose sight of the fact that the demand for any particular article is not a stationary quantity by any means—it can always be increased by a reduction in price, by an improvement in design or quality, and perhaps by superior sales organization.

A careful study must therefore be made of all trade statistics, from whatever source, that will throw light upon the total demand for the product of a factory, and some kind of an estimate must be made as to what proportion of this total demand we may be able to supply, before the size of the plant is decided upon. Careful consideration must also be given to whether and how this total demand may be increased, either by opening up new fields, by producing a more attractive article, or by more extensive and better organized sales management.

Let it be assumed that the establishment of the manufacture has been decided upon, that the amount of the output has been fixed, and that the chief points in the design and quality of the product have also been fixed. The selling department must lay its plans for marketing that product in the best possible way. The method of carrying out that programme will be discussed in greater detail later, but the selling department will have other duties than these—these other duties, however, being closely related and such that they can be carried out at the same time. They will have to advise the directorate as to the difficulty they meet with in selling the product and will have to tender that advice in such a way that an inference can be drawn as to the possibility of expanding the market (and consequently the desirability of expanding the plant) by salesmanship alone, and also as to

the necessity or desirability of modifications in design, in quality, and in methods of delivery.

In one sense, the selling department is the visible face of the business, but its most important duty is to act as a link between the manufacturing organization and its customers or prospective customers. It must interpret the requirements and desires of the customer to the works, and convey to the customer information both as to the capability of the works and as to the limitations of the works, and thus promote a thoroughly sound understanding on both sides.

For these reasons, the selling department must always maintain a close connection with the designing department, the manufacturing department, and the inspection department. Its reports to the directorate and the instructions it receives from the directorate will necessarily deal mainly with matters of policy, but it ought to be able to take up matters of detail direct with the other departments, and it will save the time and energy of the heads of the concern if, before making any recommendation on matters of policy, the selling department has been able to obtain the views of the other departments. There must, therefore, be close co-operation.

To take one example, the delivery that a salesman is able to promise in the case of a particular order will have an important, and may have a determining, effect in deciding whether or not he will get the order. A thorough understanding of the works' conditions will enable him to decide what to promise the customer, and good-will between him and the heads of the manufacturing departments will often enable him to do special things in the case of specially desirable orders, or specially important customers. In the

case of a standardized product, the salesman, who has been thoroughly familiar with what may be called the "manufacturing period," which is the length of time necessary to convert a particular batch of raw material into the finished product, must be able to advise the manufacturing department or the management whether it will meet the requirements of the market for the order to the works to be given only after the order from the customer has been received, or if it is necessary for a stock of the finished product to be kept and, if so, what size that stock must be for a given turnover.

It is pretty obvious, but there is no harm in repeating, that the costs and expenses of the selling department will rise as the efficiency of the other departments falls. It always requires good salesmanship to sell an inferior article or one at a higher price, or one where there is a considerable interval between placing the order and receiving delivery, and there is a limit to the number of times it can be done.

A salesman can set about his work with a good heart, even if his price is higher than that of his competitor, if he knows that he can give better delivery than his competitor, or if he knows that the difference in price is more than compensated for by the actual value as shown by excellence in design, and soundness of quality. The price of an article is often forgotten soon after it is paid, but bad quality or delay in delivery is never forgotten nor forgiven.

Methods

Now, let us consider the methods and tools with which the salesman can work. First of all is advertising in periodicals, second is advertising through circulars or circular letters sent out through the post,

and third (the most direct but also the most costly) is seeking business by personal visits to customers or prospective customers.

Of these three methods, the first is the most indirect, but, in relation to the number of people reached by it, is the cheapest. The last is the most direct, but, in relation to the number of people reached, the most expensive. It may be decided to use only one or all three of these methods, depending entirely on the character of the article to be sold, and whether it is essential to reach a very large number of people or a comparatively small and select class. Obviously it would be absurd to attempt to sell the product of a large soap factory direct to consumers by personal solicitation—the cost would be prohibitive and the total sales altogether too small. Products of this character will usually be sold by newspaper advertisements alone, and other methods of salesmanship will only be used in dealing with wholesale dealers and retailers. On the other hand, intricate and expensive machines cannot, as a rule, be sold by newspaper advertising alone, although it will usually be wise and economical to use this kind of advertising as a means of preparation.

If only one of these three methods is used, it will be advertising in newspapers or journals, but if all three are used they should be used in the order in which they are named, viz. :—advertising, postal canvassing, and personal canvassing. Each of the methods will then bring its own proportion of business, and they will assist and reinforce one another continuously. The proportion in which they are used will depend upon the product to be sold, the character of the classes to whom they will be sold, and, to some extent, on the progressive results obtained.

ADVERTISING

We shall probably have some idea before beginning to work, what these proportions will be, and as nearly complete as may be, the total plan of campaign should be drawn up. To begin with, carefully make out a budget of expenditure on advertising and this should be repeated at the commencement of each year, each coming year's expenditure depending to some extent upon the results obtained from the previous year's work, and also upon the condition the factory is in as regards ability to produce and the number of orders in hand. At the same time, when it is decided how much to spend in advertising, a rough preliminary selection of the journals in which our advertisements will appear should be made, and some kind of estimate as to the space that can be taken within the amount budgeted for in each of these journals, should be prepared. In selecting the journals in which to advertise, consideration will naturally be given to their circulation and the classes by which they are read. Generally speaking, the more the paper under discussion is specialized in our line, and the more its circulation is restricted to our prospective customers, then the better it is for our purpose.

For example, if the commodity is limited in use to cotton manufactures, then advertisements might appear almost exclusively in journals and magazines that are specially written for people in this line. If the appeal is made to engineers, then the advertising will be restricted mainly to engineering periodicals. On the other hand, the possibility of reaching small and restricted classes of people by a careful and judicious use of the daily press must not be overlooked. Many of the daily papers publish special numbers,

special issues and supplements for the express purpose of reaching and catering for special classes of people, and, whilst advertising in these will often be expensive, a larger number of people in a particular line may thereby be reached, than by advertising exclusively in the technical press.

The advertising campaign must be designed exactly with a view to the purpose that it is required to fulfil, and the organizer should always have clearly in mind what it is that he is aiming to do. Obviously, the ultimate aim is to convey some message to a particular section of the public. It may be to familiarize them with a name and a product, or it may be to give them a considerable amount of information about a concern and about the various selling points of a commodity. In order to convey this message, the first problem is to attract attention, and very often it is the attention of the casual and indifferent reader that is desired. Attention may be attracted in various ways; first, by occupying a large space—this is expensive but might be necessary. Second, by selecting space in the most prominent position in the journals which are being used. It is very often possible to place an advertisement in a journal in such a position that not only the careful reader but the casual observer who merely sees the paper on a bookstall must see it.

The third method in which attention can be attracted is by the design of the advertisement and whether large spaces, or what are known as "position spaces" at considerable expense, are used or not, very careful attention should be paid to the design and arrangement of the advertisements from this point of vew. If advertisements are appearing continuously in a journal, or in a number of journals,

it is not at all a bad plan to have in each advertisement some feature that is common to all, and by which they can be instantly recognized. This kind of thing has a cumulative effect, and, if the actual matter of the advertisements is interesting, it may even succeed in making people look for them. Some advertisers rely solely on the form of their advertisement to attract attention and always use the same form although perhaps modifying the matter. Other firms may arrange their initials in a striking way, or will have a striking trade mark in a prominent position in the advertisement so that after many repetitions everybody who sees the advertisement knows at once to whom it belongs and with what it deals.

Unless a concern is a very large one and can afford to maintain a really expert advertising staff, it may pay them to employ a firm of experts to design their advertisements, and these experts may be retained on contract to design all the advertising matter over a period, or may be occasionally employed for a specific purpose. But whether a concern is advertising extensively or not, whether spending large sums or not, all its advertisements must be very carefully designed. To a very large extent, on the design of the advertisement will depend whether or not it is effective in attracting attention, and consequently whether or not the money is being spent to advantage.

What is known as "keying advertisements" is often resorted to for the purpose of trying to obtain some idea of the value of advertising in particular journals, and of the value of particular kinds of advertisements. A reader is invited to address his reply to a certain department or to ask for a particular catalogue, and the department or catalogue is different

for different journals or for different advertisements. If this reference is given by the correspondent, then valuable information may be obtained as to the number of customers reached in particular cases, but, unfortunately, human nature is not built that way. Readers will often purposely refrain from giving these references, and, in consequence, these methods are not, generally speaking, very effective. Whilst it is probably not, therefore, worth while wasting much ingenunity in devising methods of keying advertisements, a note should be kept of anything that will assist the judgment in deciding whether the advertisements are effective or not.

It is not necessary, nor is it economical, that advertisements should appear in every issue of a journal. It is always less expensive, and occasionally more effective to insert them only in alternative issues, or, in the case of daily journals, on a certain day of the week.

Having decided what amount of space to take and in which journals, we shall approach the advertisement managers of the papers and obtain definite quotations for these spaces. The cost of space in any particular journal is not necessarily a fixed quantity and we must be prepared to bargain. It may be that it will pay to employ advertising agents for this purpose also.

Another thing to be borne carefully in mind is the possibility of obtaining mention in the editorial columns. Generally speaking, in the case of reputable journals, the advertising staff will not be able to promise editorial mention, and the best journals in any class lay it down as a principle that the advertisement manager has no voice whatever as to the contents of the editorial pages. Nevertheless, it is very often possible for a manufacturer to produce matter of such

general interest that the editors will publish it even though they know that the manufacturer's object in getting it published is advertisement, and they are naturally more likely to do this if the manufacturer is already represented in their advertisement columns.

Before leaving this matter, let it be emphasized that no space should be taken in any journal until the advertiser is quite satisfied as to his ability to fill it in such a manner that it will help his selling campaign and bring enquiries and orders. Either he has something to say that will be of interest to the people he is addressing, or he has not. If he has not, he had better refrain from advertising—if he has, then let him draft his advertisement in such a way that he says it briefly, concisely, and in an interesting and attractive manner.

Postal Canvassing

Postal campaigns, like advertisements, should be designed to attract attention, to convey information and, if possible, to provoke a reply. If the matter that is being sent through the post is printed matter, it must be designed and printed in such a way that it will strike the eye of the man who receives it, and will convey to him something that will make him wish to read it. If the matter is in the form of a letter, the letter may be produced so as to give its recipient the impression that it is not an advertisement but a special letter addressed to him personally. Circular letters are often reproduced now in such a manner that it is almost impossible to tell that they are not individually written and signed, and, providing the matter that the letter contains is really of such a character that it may interest the recipient, there is perhaps not very much harm in this kind of deception.

It must be used, however, with care and discretion or it may cause irritation and prejudice. The matter should be carefully chosen, and the wording should be very carefully decided upon, so as to produce a good effect on the reader.

The postal campaign may consist of a complete series of letters carefully graduated in tone—each one of the series calculated to add to the effect already presumed to have been produced by its predecessors, and all leading up to the one object, namely: to interest the prospective customer and provoke a reply. Obviously, when a reply has been received it must be dealt with individually, and no further letters of that particular series must be sent to that particular person.

At the outset of a postal campaign, lists of prospective customers must be drawn up, and the names on these lists must be classified as far as possible, so that the type of letter or circular that is sent to each shall be as nearly as possible designed to fulfil the purpose with the person receiving it. These lists should be revised and added to from time to time: the more care used in classifying the mailing list and designing the matter to be sent out to suit the particular classes to which it is sent, then the more effective will the postal campaign be.

Personal Visits

A personal visit may be for either one of two purposes. It may be to follow up and reinforce the advertising and postal campaign, and thus to assist in breaking new ground, or it may be for the purpose of following up enquiries already received. In any case, the visit should always be carefully announced by letter and, as nearly as possible, the day and hour

at which the visit will be paid should be given. If, for any reason, it is not possible to pay a proposed visit on the day for which it is announced, a note of explanation and apology should be sent.

The representative that is going to pay the visit should be worthy of the firm that he is representing and should be announced in a becoming manner. If he occupies an important position, his position should be stated, and he should carry all the prestige that the firm can lend him. The possibility of obtaining an interview with an important person will very often depend entirely on the manner in which the visit is announced. As far as possible, an indication of the purpose of the visit should be given in the letter of announcement. In announcing a visit to follow up an enquiry, care should be taken that the reference on the enquiry or the signature should be mentioned in the letter of announcement in order that the firm receiving the letter may be in no doubt as to whom the visitor is to see. If, however, the visit is in furtherance of a specific campaign, or following up circular letters that have preceded the visit, reference may be made to these. Representatives should always send back to their head office, the same night that calls have been made, a report of each call. These reports should be carefully analysed at the head office, interesting matter contained in them should be recorded, and any following up or supporting that requires to be done should be done punctually and effectively.

Representatives and salesmen, before being sent out, should receive very careful training. They should be thoroughly familiar with the firm they are representing and with every detail of the product that they are trying to sell. They should be carefully coached in all

the points both in favour of and against the goods they are selling, and should be instructed as to the proper method of dealing with questions and criticism. As far as possible, a representative should be posted as to the character of the man he is likely to interview in order that he may decide for himself before the interview what line he will take and how he will approach the customer. If he is a student of human nature—and every salesman should be a student of human nature—he will almost instinctively suit his methods to the customer, and the more information he can receive as to the personality that he is going to deal with beforehand, then the better he will come off. It goes without saying, that a salesman must be a convinced believer in the goods that he is going to sell. It is obvious that a salesman who is doubtful as to the value of his goods cannot possibly convince a doubtful or indifferent customer, and the more sincere enthusiasm a salesman can show, the better hearing he is likely to get and the more likely to obtain orders. It has already been stated that the representative must be thoroughly grounded in all the details of the goods that he is going to sell—there is nothing that will tell more disastrously against a salesman than his being only superficially informed. For the time being he is the firm that he represents, and he ought to be able to give the man he is visiting all the information that is obtainable. He must be at all points better informed, both as to the manufacture, as to the quality, and as to the utility of the goods that he is going to sell, than the man he is interviewing, otherwise he had better avoid the interview. He is for the time being a specialist in his particular line and he knows all that is to be known about his particular goods. Incidentally, he should

know a good deal about the business of his prospective customer in order to discuss, with intelligence, the use that the customer may make of his goods. He should never attempt to convey the impression that he knows or thinks he knows more about the customer's business than the customer does himself, and should always defer to the customer in this respect. He should avoid the use of the same phrases over and over again and should avoid the use of what is known as salesman's "patter." He should not repeat a story parrotwise, but should endeavour to convey something of his own personality in everything that he says, and should, as far as possible, say it as though he were saying it for the first time.

A salesman must be carefully kept in touch with the head office, both by correspondence and by visits. Every once in a while, he should be encouraged to spend a day at the head office to give verbal reports and to receive instructions from the sales manager or head of the firm, and should be given frequent opportunities of going through the factory and keeping in touch with the heads of all departments in order that he may be fully advised as to all progress made and as to improvements (actual or in contemplation) either in the design or quality of the product, or of the methods of manufacture.

Branch Offices

So far, it has been assumed that all the work has been done from the head office, which is situated at or near the factory. It may be necessary, however, to establish branch selling offices, and these will require careful consideration. When it is contemplated to open a branch office in a district, it is a good plan to put the future manager of that office in the

district for a time as a resident traveller to allow him to become familiar with the district and with the firm's customers in that district.

Separate statistics should be kept as to the business in the district, and from these some idea can be formed as to the expenditure that can be sanctioned in the matter of office accommodation and assistance. As far as possible, the duties of the manager of a branch office should be clearly defined. It may be that he will simply canvass for orders and follow up enquiries, or it may be that he can give quotations and receive orders, and, in this latter case, he must be carefully instructed as to any latitude that he is allowed as regards prices, and must be carefully posted as to the possibilities of deliveries. He will naturally receive copies of all enquiries coming from his district, and should also receive copies of all the replies and of all letters addressed to customers in this district. He will return reports to head office of all important calls made, and should be encouraged to record for his own use and send on to head office whatever information he is able to obtain in the ordinary course of business as to the standing, financial and otherwise, of the people he is dealing with. A branch manager in a particular district will naturally obtain a connection that is to some extent personal to him, and within limits, should be encouraged to do so. Provision must be made, however, in case the branch manager severs his connection with the firm and takes with him a connection that has been built up at the expense of and on behalf of the firm.

Branch managers may be paid salary only, or may receive in addition to the salary a commission that will depend upon the turnover of their branches: or they may, which is perhaps a better plan, receive a

salary and a commission that depends upon the profits or the turnover of the firm as a whole. A branch manager, who depends for his remuneration solely on the prosperity of his own branch, may, under certain circumstances, become rather awkward to deal with. He may push the interests of his own branch to the detriment of other branches, or even to the detriment of the firm as a whole. It should be made apparent to him, therefore, beyond question, that he is working for the firm as a whole, and not only for his particular branch. Within these limits, however, a spirit of emulation and rivalry between the various branches is a good thing, and should be encouraged. This can probably be done quite sufficiently by publishing periodically amongst branch managers statistics as to the trading results in the various branches.

Agencies

When agencies are given for the sale of the product of the firm, great care must be taken both in selecting suitable people to hold these agencies and in drawing up the agency agreements. The whole question of agencies is one that is full of difficulties, especially in foreign countries, and it has to be dealt with in each case with a full knowledge of the product to be sold, and of the trade customs and conditions in the territory to be exploited, as well as of the territory itself. Where no agency or business exists in a particular territory, it is possible to begin with an agency that gives us at the same time a minimum of responsibility and a minimum of control, and convert that agency gradually over a long period of years into a branch that is completely under our control and is really analogous to our home branches.

In first opening up, it will probably not be difficult to find a reliable agent who will undertake the sale of our product in a particular territory, buying for re-sale against priced lists or individual quotations. In this case, the agency business belongs to the agent and is entirely under his control. It may be made a part of the agreement either that he shall re-sell at prices agreed upon, or that he shall guarantee a certain minimum turnover. The purpose of this is to insure that he shall not seriously restrict the turnover in his territory by selling at exorbitant prices. In the beginning an allowance may be necessary in aid of advertising and propaganda, and this will strengthen the position in dealing with it. In selecting an agent, however, who is sufficiently strong financially to carry out an arrangement of this kind or who has the necessary organization, care must be taken to see that he is not handling competing lines, and if we are really depending upon getting the turnover in this territory, we must make sure that some portion of his staff is going to devote itself to push our business. An arrangement of this kind would be made for a number of years and would probably be automatically renewable at the end of the period unless notice were given by either side. If the concern definitely contemplates controlling its own business in this particular territory at some day or other, this should be kept in mind in drafting the agreement, and the agreement must reflect the intention either to abandon the arrangement or to modify it radically.

The next step towards obtaining control will be to stipulate that the salesmen, who are selling the goods, shall be nominated by the firm appointing the agent, or, at any rate, trained in its works, and arrangements should be made for such reports to be made as to the

business in this territory as will provide a sufficient knowledge, should occasion require it, to denounce the agency and open up a branch. It must always be kept in mind, that the agent may be so efficient and that the relations with him may be so pleasant and profitable that the concern will be content to leave the handling of its business in his territory in his hands, but preparation should always be made for the other eventuality.

Bearing in mind that an agent's duty is to represent the firm in his territory, the principals must see that he is kept thoroughly equipped with information as to the goods and the happenings in the works and home office. He should be encouraged to pay frequent visits to the works, and no opportunity of making him familiar with the product and of drawing him in closer relations with the home office staff should be lost.

To sum up then, the points to pay attention to are—

1. The agent must be a reliable man and must have such a position in his own territory that he can influence business in favour of his principals.

2. Some arrangement must be made to insure that payment for the goods is received; payment terms must be carefully considered and agreed upon to commence with.

3. Arrangements must be made to control the selling price in the agent's territory or, alternatively, the agent should be required to guarantee a minimum turnover.

4. The agreement should be so drawn as to insure that the agent will be strongly interested in working in harmony with the home office and in carrying out the selling policy laid down.

5. The contingency of the agency agreement being

allowed to lapse and the agent ceasing to handle the goods, must be contemplated, and possible means of carrying on considered.

Once suitable agents are appointed and reasonable agreements made, the difficulties that arise are usually due to lack of understanding, and can be avoided by frequent interchange of views both by correspondence and visits both ways.

Branch Offices *v.* Agencies

The differences that really matter between branch offices and agencies can be very briefly stated. On the one hand a concern may have an agency for which it has no financial responsibility and no expense and, at the same time, absolutely no control except the power to refuse the supply of goods, and that power doubtful. On the other hand, it may have a branch office for which it is wholly responsible, of which it must bear the whole expense, and over which it has absolute control. All kinds of arrangements can be made between these two extremes, and if this policy be decided upon beforehand, as has been suggested, there may be a progressive change from one to the other.

Customers' Characteristics

The home office should have an index to its customers. This index would, in the beginning, be merely a copy of part of the mailing list, containing nothing but the name and address and business of the customer. But, as correspondence is received and as visits are paid and travellers' and representatives' reports received, all information that can be gleaned therefrom, either as to the personal characteristics of the customers or the customers'

employees with whom business is conducted, as to the peculiar requirements, from the home office point of view of his business, and, not least important, as to the desirability of extending credit to him, should be collected and entered in this index.

No salesman should go out to interview a customer without having seen this index so that the customer may feel, if he is called upon to receive different salesmen at different times, that he does not have to start at the beginning in each case, but that he can start with a new man where he left off with the old one, and there is no real break in continuity. Methods of this kind are absolutely necessary in order that the business may be continuously carried on without interruption as the result of casualties amongst the staff. In saying this, of course, the desirability of the same salesmen always handling the same customers is not under-estimated.

Re-unions

The necessity for maintaining close touch between the salesmen and the home office as well as works departments has already been emphasized. This is really so important, where there is a large selling staff and considerable territory to be covered, that it is worth while giving the matter careful consideration.

In addition to the weekly or monthly individual visits of salesmen, it is not a bad plan to have them all home at the same time once or twice a year, and to make it something of a social as well as a business event. Salesmen are quite apt to consider and feel themselves rather foreign to the factory, and their connection with it should be emphasized and strengthened on all possible occasions. An annual re-union of salesmen or, as it is known in the United

States, "A Sales Congress," is a very good means of making the salesmen better acquainted with one another and with the home concern, of smoothing out differences, or re-unifying methods, of bringing up to date their information and knowledge, of comparing results obtained by different salesmen in different territory, and generally of promoting a feeling of friendliness, unity and co-operation, not only between the salesmen themselves, but between the home office and the salesmen, and between the selling staff as a whole, and the designing and manufacturing departments of the concern.

Conclusion

A selling campaign has many points of resemblance to a military campaign. It should be very carefully planned and organized beforehand, and should be carried out with almost mathematical precision. The more carefully it is planned and organized beforehand, then the more sure success will be and the less it will cost. Success in sales management can, of course, be obtained by haphazard work, and very often is so obtained, in the sense that sufficient orders are received and sufficient sales made to keep the factory going, but this is not necessarily, by any means, complete success. The cost of selling is a very important factor, and this will always be reduced by careful organization which aims at obtaining cheaply orders that come easily, and using only the more expensive methods to make the more difficult sales.

As has been stated, the most expensive method of making sales is by personal salesmanship, and, in the long run, this may and probably will have to be resorted to just as it is not always possible to avoid frontal attacks in a military campaign.

Personal salesmanship involves two personalities—the personality of the salesman and the personality of the customer. The personality of the customer should be studied very carefully, and the accumulated knowledge should be recorded in the manner indicated above. Ability on the part of the salesman to make sales by virtue of his personality is rather rare, its use is costly and it is only effective for the particular occasion on which it is used. For these reasons, as far as possible, sales should be made by other methods, and personal salesmanship only be used when these other methods fail, or cannot be used.

Finally, and again it should be remembered that the most efficient and cheapest salesmen the firm can have, are its own satisfied customers ; and it is impossible to exaggerate the extent to which the sales organization will be strengthened, and the cost of making sales reduced, by efficient and punctual production in the factory.

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